(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 098 228 A2

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
09.05.2001 Bulletin 2001/19

(51) Int. Cl.⁷: **G03G 15/01**, G03G 21/18

(21) Application number: 00117336.8

(22) Date of filing: 21.08.2000

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 02.11.1999 JP 31194099

(71) Applicant: Hitachi, Ltd.
Chiyoda-ku, Tokyo 101-8010 (JP)

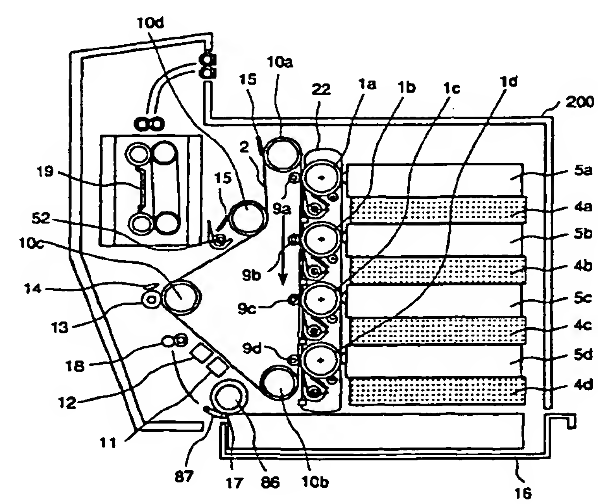
(72) Inventors:
- Yamamoto, Masashi
Hitachi-shi, Ibaraki 319-1222 (JP)
- Miyasaka, Toru,
Erudemu Otsuka room 107
Hitachi-shi, Ibaraki 319-1225 (JP)
- Nakano, Masaru
Tsukuba-shi, Ibaraki 300-2637 (JP)
- Shimada, Akira
Hitachi-shi, Ibaraki 319-1225 (JP)
- Mori, Kenji
Tsuchiura-shi, Ibaraki 300-0016 (JP)
- Sasaki, Akira
Hitachi-shi, Ibaraki 316-0012 (JP)
- Wakamatsu, Kazuhiro
Hitachi-shi, Ibaraki 316-0025 (JP)

(74) Representative:
Beetz & Partner
Patentanwälte
Steinsdorfstrasse 10
80538 München (DE)

(54) **Photoconductor unit and image forming system**

(57) In order to provide an image forming system characterized by compact configuration, high speed printing, high picture quality recording and excellent maintainability without image misregistration, an image forming system is provided, wherein multiple photoconductors (1a-d) are arranged on one of the surfaces of the intermediate transfer belt (2) stretched long in the longitudinal direction, and a fusing device (19) on the other surface, with photoconductor integrated in one unit (22).

FIG. 1



EP 1 098 228 A2

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an image forming system including a copier, printer and fax machine to form color images based on electrophotographic technology.

[0002] Electrophotographic technology forms a static latent image corresponding to image data on the photoconductor where electrically charged toner particles are deposited on the photoconductor corresponding to the potential pattern of the static latent image, thereby visualizing the latent image as toner image. Then this toner image is transferred onto a recording medium such as paper to form an image on the paper. If a color image is to be formed in this process, toner of multiple colors, for example, yellow, magenta and cyan, must be superimposed to form an image.

[0003] An image forming system to form color images is variously characterized in the method of superimposing toner particles of different colors. Proposed color image forming methods can be broadly classified into two types; a repeated development method where toner of various colors is developed repeatedly on one photoconductor to get color images, and a simultaneous development method where toner particles of various colors are developed on multiple photoconductors simultaneously to get color images. The following describes the details of various color image forming methods:

[0004] In the repeated development method, one photoconductor is used to form a color image. This methods includes the following three methods; photoconductor color superimposition, transfer drum and intermediate transfer.

[0005] Of these methods, intermediate transfer method capable of recording high quality pictures is disclosed in Japanese Patent Laid-Open NO.137179/1996, where multiple development devices which develop different color toner particles around the photoconductor and intermediate transfer device are arranged, and the toner image formed on the photoconductor is transferred on the intermediate transfer device. This is repeated for each color and toner particles of multiple colors are superimposed on the intermediate transfer devices. After that, the toner image on the intermediate transfer device is transferred on paper, thereby producing color image outputs.

[0006] The simultaneous development method is disclosed in Japanese Patent Laid-Open NO.186894/1998 and Japanese Patent Laid-Open NO.260593/1998, for example. This method has multiple photoconductors provided, and toner images are formed simultaneously by each photoconductor. Toner images are transferred synchronously with paper feed, thereby forming color images. This color image forming method is also called tandem method, and is typical of the simultaneous development method.

SUMMARY OF THE INVENTION

[0007] Increasing use of colored and digital data in office environments has resulted in growing demands for color images to be printed on recording media such as paper. A color image forming system to meet these demands is required to meet the four performance requirements; (1) compact configuration to allow installation at limited installation site in an office, (2) high picture quality to produce photo outputs, (3) compatibility with a great variety of recording media such as the OHP and cardboards in addition to plain paper, and (4) high speed to ensure a great volume of business documents to be printed in a limited time.

[0008] Of these, two requirements -- (1) compact configuration which is a prerequisite for office installation and (2) high speed printing resulting from color image processing technology and high speed transmission technology supported by technologically advanced PCs and networks -- are important performance requirements which are essential to the subsequent color image forming systems.

[0009] The tandem method introduced above facilitates this speed increase. This method forms toner images of various colors almost simultaneously. It allows color images to be formed at the same speed as that of the monochrome printer. However, images are created independently for each photoconductor, and this makes it very difficult to superimpose toner images of various colors. Registration of toner images of various colors depends on layout accuracy of each photoconductor and exposure device such as pitch and parallelism. If they are not laid out with high accuracy, picture quality will be subsequently deteriorated; for example, variations of hues, a double image or other troubles will result from misregistration of toner images of different colors. Furthermore, this layout accuracy will be subsequently reduced when the user mounts or dismount the consumable photoconductor at the time of replacement. When the tandem method is used, registration of toner images of different colors poses a serious problem if recording of high picture quality is to be ensured.

[0010] One object of the present invention is to provide a compact and high-speed image forming system which ensures recording of high picture quality.

[0011] Another object of the present invention is to provide a image forming system characterized by excellent maintainability.

[0012] An image forming system according to the present invention comprises multiple photoconductors, multiple exposure devices to form static latent images on each of said photoconductors, multiple development devices to form toner images on each of said photoconductors, an intermediate transfer device to form a color toner image by superimposing said toner images, a

transfer device to transfer said color toner image to a recording medium, and a fusing device to fuse said color toner image on said recording medium; wherein said multiple photoconductors form one integral unit.

[0013] A photoconductor unit has multiple photoconductors arranged in a line, multiple charging devices to charge each of said photoconductors uniformly, and multiple photoconductor cleaners to clean each of said multiple photoconductors. Said multiple photoconductors, multiple charging devices and multiple photoconductors cleaners are configured in one unit.

[0014] Since multiple photoconductors are used for printing, higher printing speed is ensured than that when only one photoconductor is used. Multiple photoconductors configured in one unit eliminate the possibility of displacement of photoconductors due to mounting and dismounting at the time of replacement. Recording of high picture quality is ensured without image misregistration during printing. Maintainability is also improved at the same time.

[0015] Furthermore, another image forming system according to the present invention comprises multiple photoconductors arranged in a longitudinal line, multiple development devices and multiple exposure devices arranged on one side of said multiple photoconductors, an intermediate transfer device arranged on the other side of said multiple photoconductors, and a form cassette arranged below said multiple photoconductors; wherein said multiple development devices and multiple exposure devices are arranged in the vertical direction to said multiple photoconductors, and said multiple development devices and multiple exposure devices are arranged alternately with respect to the direction of said multiple photoconductors.

[0016] Such a layout configuration allows high speed printing despite use of multiple photoconductors. This permits a compact image forming system to be provided.

[0017] Fixing the exposure devices on the enclosure side of the image forming system eliminates the possibility of design-based misregistration of exposure. This makes it possible to provide an image forming system characterized by a stable exposure and high quality image recording.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Figure 1 represents one embodiment of the image forming system according to the present invention;
Figure 2 is a detailed view showing the configuration of the photoconductor unit of the image forming system according to the present invention;
Figure 3 represents details around the photoconductors of the image forming system according to the present invention;
Figure 4 shows misalignment of multiple photoconductors of the image forming system according to the present invention;
Figure 5 shows how to mount and dismount each process of the image forming system according to the present invention;
Figure 6 represents an embodiment of the exposure device of the image forming system according to the present invention;
Figure 7 represents another embodiment of the exposure device of the image forming system according to the present invention;
Figure 8 represents still another embodiment of the exposure device of the image forming system according to the present invention;
Figure 9 represents an embodiment of the LED light source used as an exposure device of the image forming system according to the present invention;
Figure 10 is a schematic drawing representing the exposure device consisting of a LED light source used in the image forming system according to the present invention;
Figure 11 represents an embodiment of the development device of the image forming system according to the present invention;
Figure 12 represents another embodiment of the development device of the image forming system according to the present invention;
Figures 13A, 13B represent an embodiment of the belt offset correction mechanism of the image forming system according to the present invention;
Figures 14A, 14B represent an embodiment of the intermediate transfer belt unit cleaner of the image forming system according to the present invention;
Figure 15 represents an embodiment of the fusing device of the image forming system according to the present invention;
Figure 16 represents another embodiment of the fusing device of the image forming system according to the present invention;
Figure 17 represents an embodiment of the paper heating component of the image forming system according to the present invention;
Figure 18 is a drawing illustrating the bias voltage applied to each process in the image forming system according to the present invention;
Figure 19 represents an embodiment of the transfer voltage controller of the image forming system according to the present invention;
Figure 20 is a drawing illustrating the image sensor and image misregistration of the image forming system according to the present invention;
Figure 21 represents an embodiment of adding a form cassette to the image forming system according to the present invention;
Figure 22 represents an embodiment of the duplex printing mechanism of the image forming system according to the present invention;
Figure 23 represents another embodiment of the

duplex printing mechanism of the image forming system according to the present invention;

Figure 24 represents still another embodiment of the duplex printing mechanism of the image forming system according to the present invention;

Figure 25 represents another embodiment of the image forming system according to the present invention;

Figure 26 represents still another embodiment of the image forming system according to the present invention;

Figure 27 represents one embodiment of the image forming system according to the present invention which is provided with an intermediate transfer belt long in the lateral direction; and

Figure 28 represents another embodiment of the image forming system according to the present invention which is provided with an intermediate transfer belt long in the lateral direction.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] The following description will be made with reference to drawings.

(First Embodiment)

[0020] Figure 1 represents a schematic cross section of the image forming system as the first embodiment according to the present invention. It provides compact image forming system characterized by high speed printing and high quality image recording.

[0021] Photoconductors 1a, 1b, 1c, and 1d corresponding to four colors of the toner; yellow, mazenta, cyan and black required for formation of a color image are arranged longitudinally at the center of enclosure 200. They are connected rotatably about each axis by supports, and are provided as an integral photoconductor unit 22.

[0022] Furthermore, the intermediate transfer belt 2 is pulled by four belt tension rollers 10a, 10b, 10c and 10d to contact photoconductors 1a, 1b, 1c, and 1d arranged longitudinally, and is longitudinally arranged almost in the horizontal direction with respect the multiple photoconductors. In this case, auxiliary transfer rollers 9a, 9b, 9c and 9d to transfer the toner image from the photoconductor onto the belt through intermediate transfer belt 2 are provided at the position in face-to-face relation to photoconductors 1a, 1b, 1c, and 1d. In the photoconductors 1a, 1b, 1c, and 1d arranged in the longitudinal direction, exposure devices 4a, 4b, 4c and 4d to expose the surfaces of photoconductors 1a, 1b, 1c, and 1d and to form static latent images, and development devices 5a, 5b, 5c and 5d to make the static latent image visible are arranged alternately in the longitudinal direction on the side opposite to where the intermediate transfer belt 2 is arranged. A slight clearance may be present between the exposure devices 4a, 4b, 4c and 4d and development devices 5a, 5b, 5c and 5d, or other components may be present. To make the equipment more compact, this space is preferred to be as small as possible.

[0023] Photoconductors 1a, 1b, 1c, and 1d rotate in the counterclockwise direction in Figure 1. They rotate from upward to downward at the position in contact with so-called intermediate transfer belt 2. This rotation determines the arrangement for other printing process and rotary direction of the intermediate transfer belt 2. In this case, intermediate transfer belt 2 rotates from upward to downward at the position in contact with the photoconductor, similarly to the case of photoconductors.

[0024] An image sensor 11 to detect the misregistration of color images, an electric charge eliminator 14 for paper 14 to separate paper from intermediate transfer belt 2, and an intermediate transfer belt cleaner 15 to clean toner from the intermediate transfer belt 2 are installed around the perimeter of the intermediate transfer belt 2. A belt discharged toner collector 52 is provided to collect the discharged toner cleaned by his intermediate transfer belt cleaner 15. Furthermore, a form cassette 16, paper feed mechanism 17, separation pad 87, resist roller 18 and fusing device 19 are arranged on the paper feed path.

[0025] Figure 3 shows the enlarged view showing the construction around the photoconductor. The following describes around photoconductor 1a. This also applies to other photoconductors 1b, 1c, and 1d.

[0026] A charging device 3a to charge the photoconductor 1a electrically, a exposure device 4a, a development device 5a, an intermediate transfer belt 2, an erase lamp 8a to eliminate electric charge form the surface of photoconductor 1a, a photoconductor cleaner 6a to clean the remaining toner, a discharged tone collector 7a to collect discharged toner cleaned by the photoconductor cleaner 6a, and an auxiliary transfer roller 9a to assist transfer on the intermediate transfer belt 2 the toner image formed on the photoconductor 1a by development device 5a in the intermediate transfer belt 2 are provided around the photoconductor 1a.

[0027] This embodiment provides photoconductor cleaners 6a, 6b, 6c and 6d to remove the toner remaining on the photoconductor 1a after the toner has been transferred onto the intermediate transfer belt 2, and the toner of the toner image deposited on the intermediate transfer belt 2 due to reverse transfer.

[0028] If toner remains on the photoconductor 1a, uneven exposure or mixing of colors of the toner of the development device 5a will occur. This makes it necessary to ensure perfect elimination of these toner particles. For photoconductor cleaners 6a, 6b, 6c and 6d, cleaning blades may be used to clean the photoconductor. The cleaning blade rakes off the toner by an elastic blade formed of rubber and the like brought directly in contact with the photoconductor, thereby ensuring per-

fect cleaning. Furthermore, the cleaning blade is designed in a simple construction; it is made of only the blade. This construction permits the cleaner to be designed in a compact configuration at a reduced cost.

[0029] The toner raked off by the photoconductor cleaners 6a, 6b, 6c and 6d is discharged into the discharged tone collectors 7a, 7b, 7c and 7d arranged below photoconductors 1a, 1b, 1c, and 1d by gravity. The discharged tone collectors 7a, 7b, 7c and 7d transport the toner by rotating spiral rollers. Toner collected by discharged tone collectors 7a, 7b, 7c and 7d is finally transported into the discharged toner case through the discharged toner outlet path 102 arranged in the system, and is collectively discarded.

[0030] To stabilize the potential on the surfaces of photoconductors 1a, 1b, 1c, and 1d, it is effective to dampen the potential on the surface of the photoconductor before electrical charging. Reduction of the potential on the surface of the photoconductor weakens electrostatic connection between the photoconductor and toner, and ensures a perfect cleaning of the toner remaining on the photoconductor. Furthermore, erase lamps 8a, 8b, 8c and 8d are provided to eliminate electric charge from photoconductors 1a, 1b, 1c, and 1d. The erase lamps 8a, 8b, 8c and 8d represent a LED array, which eliminates electric charge from the photoconductor by light irradiation.

[0031] The following describes the positional relationship of photoconductors 1a and 1b and position of the image with reference to Figure 4: Figure 4 (a) shows the case when photoconductors 1a and 1b are located at proper positions. Figure 4 (b) shows the case where photoconductor 1b is misaligned. Figure 4 (c) indicates superimposition of images formed by photoconductors 1a and 1b 20 and 21.

[0032] The image forming system according to the present invention is required to produce outputs of high resolution and high quality images such as photos. To achieve high quality recording, it is necessary to ensure accurate printing of fine dots and improved uniformity of solid images. Variations of hues, a double image or other troubles will result from misregistration of toner images of different colors, and a substantial deterioration of high picture quality will occur. To prevent this, registration of the images of different colors must be done accurately.

[0033] Layout position of the photoconductors and exposure devices is important for accurate registration of the images of different colors.

[0034] Exposure is started by the exposure device 4a on the photoconductor 1a positioned on the upstream side in the rotating direction of intermediate transfer belt 2. The image 20 formed by the photoconductor 1a on the intermediate transfer belt 2 is superimposed on image formed by photoconductor 1b 21; therefore, image exposure on the second photoconductor 1b located immediately below the photoconductor 1a is delayed by the time required for electrostatic latent image to be moved from the exposure position to the position of contact with intermediate transfer belt 2, and by the time required for the surface of intermediate transfer belt 2 to pass by the space between the photoconductors 1a and 1b, from the time of starting image exposure on photoconductor 1a by exposure device 4a. Consequently, distance from the exposure position on each photoconductor to the position of contact with intermediate transfer belt 2, distance between the photoconductors 1a and 1b and the surface speed of photoconductor and intermediate transfer belt are important for registration of the images of different colors. In this case, if the photoconductor 1b is displaced from the specified position as shown in Figure 4(b), the tips of images 20 and 21 are also displayed, accordingly. Thus, the layout position of the photoconductor and exposure device is required to be very accurate.

[0035] However, surface wear and photosensitive characteristics of the photoconductor deteriorate during printing, with the result that the photoconductor have to be replaced. In the image forming system used in business environment, users themselves are required to replace the consumables. Configuration to allow easy replacement will conversely deteriorate layout accuracy of the photoconductor. High-accuracy layout is currently very difficult.

[0036] When photoconductors are divided into separate units to be replaced individually, layout accuracy of each photoconductor crucial to the registration of the images of different colors will be deteriorated because each photoconductor is a separate unit and is separately replaced.

[0037] According to the configuration used in the embodiment shown in Figure 1, multiple photoconductors 1a, 1b, 1c, and 1d to form the images of different colors are fixed and laid out in a photoconductor unit 22, and the entire photoconductor unit 22 is replaced.

[0038] In the present embodiment, a photoconductor unit 22 is designed so that photoconductors 1a, 1b, 1c, and 1d, charging devices 3a, 3b, 3c and 3d, photoconductor cleaners 6a, 6b, 6c and 6d, and discharged tone collectors 7a, 7b, 7c and 7d are integrated into one unit. Erase lamps 8a, 8b, 8c and 8d may be laid out inside or outside the photoconductor unit 22.

[0039] If the photoconductor unit 22 itself is displaced from the specified position as shown in Figure 4, photoconductors will be laid out at displaced positions, as shown in Figures 4 (a) to 4(c). However, since photoconductors are designed as a unit, displacements of photoconductors 1a and 1b are equal to each other. This makes images formed by the photoconductors 1a and 1b 20 and 21 to be displaced from the normal position and to be transferred onto the intermediate transfer belt 2, but displacements of images 20 and 21 are equal to each other. Accurate superimposition of images is ensured in the final phase. In this case, displacement of the superimposed images of different colors at tip positions is sufficiently smaller than the accuracy of registra-

tion between the image tip and paper tip, when paper as recording medium is fed and transferred, and this does not pose any problem in practice. As discussed above, photoconductors 1a, 1b, 1c, and 1d are fixed and laid out inside the photoconductor unit 22 so that the photoconductor unit 22 can be replaced. This configuration permits accurate registration of the images of different colors, and makes it possible to implement an image forming system characterized by high quality recording.

[0040] For toner registration for images of different colors, layout accuracy of the exposure devices 4a, 4b, 4c and 4d to expose photoconductors 1a, 1b, 1c, and 1d is also important. For example, when exposure devices to expose photoconductors are installed on the component which can be opened and closed, the layout position of each exposure device may be displaced, and image misregistration is likely to occur, if these components are opened and closed.

[0041] Thus, in the image forming system according to the present embodiment, exposure devices 4a, 4b, 4c and 4d are laid out fixed to the enclosure 200 of the, thereby ensuring accurate layout positions of exposure devices 4a, 4b, 4c and 4d, without the possibility of being displaced.

[0042] However, very accurate registration of the images of different colors is essential to increase resolution to meet higher definition image recording requirements. The configuration according to the present embodiment may be insufficient.

[0043] To ensure accurate registration of the images of different colors in such cases, the present embodiment has a mechanism to allow a sample pattern to be printed when consumables have been replaced or there is a big misregistration of images for some failure, and to allow a user or operator to adjust the position where image appears on the screen, based on the printed pattern, thereby ensure high quality recording at all times.

[0044] To ensure accurate registration for images of different colors furthermore, the above method is improved; the position of each color image is detected, and the timing for writing and position control mechanism can be provided in conformity to misregistration of image. This image misregistration control unit comprises an image sensor 11 to detect the position of each image (for example, four color images of yellow, magenta, cyan and black), and a misregistration calculation unit to determine the degree of misregistration of the actually printed image based on the detection result by the image sensor 11, and an image compensation unit to compensate for each image based on the result of the misregistration calculation unit. For Image position, the pattern which permits easy misregistration of images of different colors, for example, image position detection pattern is printed on the intermediate transfer belt 2. Then the time when the image is detected or other related data is measured, thereby ensuring accurate measurement of the image position. This image position detection pattern is printed on the non-image area such as between sheets of paper at a predetermined timing, for example, at the time of the system startup or during printing.

[0045] The following describes the embodiment of an image sensor 11. The image sensor 11 is laid out on the intermediate transfer belt 2 to detect the position of images of different colors on the intermediate transfer belt 2. The image sensor 11 has a built-in light emitting unit and light receiving unit. The light issued from the light emitting unit is applied to the surface of the intermediate transfer belt 2, and its reflected light is received by light receiving unit.

[0046] The intensity of reflected light is different, depending on whether or not there is toner on the intermediate transfer belt 2. So this difference is detected to determine presence or absence of toner. In this case, to improve the toner image position detection accuracy, the spot diameter of the light emitted from the light emitting unit must be made smaller than the image misregistration tolerance. According to the present embodiment, misregistration of images of different colors is specified not to exceed 100 microns. So the spot diameter of the light emitted from the light emitting unit does not exceed 100 microns. A laser diode and LED can be used as the light emitting unit. As an image sensor, it is possible to use the potentiometer to measure the potential of the toner as electrically charged particle, in addition to the above-mentioned light.

[0047] Misregistration of toner images of different colors can be classified as (1) parallel misregistration of images of different colors in the vertical and lateral direction, (2) displacement of image angle, and (3) extension and contraction of images in the vertical and lateral direction. In the present embodiment, a total of two image sensors 11 to detect misregistration of images are laid out on the right and left of the intermediate transfer belt 2, as shown in Figure 20. Measurement by multiple image sensors 11 ensures measurement of detailed image positions. If the detection by image sensor 11 shows that misregistration of images is greater than expected, misregistration should have occurred to the exposure write timing and the position in each process. Based on this result, the misregistration calculation unit determines the manner and degree of image misregistration. From the result of measuring rear end position and right/left positions as well as each image pattern tip position, the misregistration calculation unit determines the image positions and image extension or contraction. For example, measurement of each line of wedge type character pattern reveals the tip position and angle deviation.

[0048] Based on this result, the image compensation unit adjusts the x and y coordinates for the write position of the image to be printed actually, and image angle and length. When images of different colors are rotated, expanded and contracted by the image compensation unit, it is possible to use the method where

the entire images to be printed are stored in the memory and image processing is carried out.

[0049] The image sensor 11 is laid out opposite to the surface where the toner of intermediate transfer belt 2 is deposited, so it may be contaminated by toner splashed from the intermediate transfer belt 2. This will cause detection accuracy to be decreased. To avoid this, it is possible to provide a mechanism to clean the image sensor 11. To prevent the sensor from being contaminated, it is effective to put a cover hide the light emitting unit and light receiving unit of the image sensor 11 when image position is not measured.

[0050] Furthermore, the level of the light detected by the light receiving unit of the sensor is changed in conformity to the volume of toner deposited, so it is possible to detect the volume toner deposited on the intermediate transfer belt 2. When the picture quality is to be improved by providing a control mechanism to control the intensity of exposure, exposure time, and development bias, etc. in conformity to the volume of toner deposited, as previously discussed, the image sensor 11 according to another embodiment can be used as a sensor to measure the volume of deposited toner.

[0051] Figure 2 shows the details of an embodiment of the above-mentioned photoconductor unit 22. Figures 2 (a) and (b) are the side views of the photoconductor unit. Figure 2 (c) is a plan of the photoconductor unit, and Figure 2 (d) is a side views on the opposite side of Figure 2(a).

[0052] As discussed above, the photoconductor unit 22 in Figure 2 (b) comprises multiple photoconductors 1a, 1b, 1c, and 1d, photoconductor cleaners 6a, 6b, 6c and 6d to clean each of photoconductors 1a, 1b, 1c, and 1d, discharged tone collectors 7a, 7b, 7c, and 7d to collect the discharged toner cleaned by each of the photoconductor cleaners 6a, 6b, 6c and 6d, and charging devices 3a, 3b, 3c and 3d to electrically charge the photoconductors 1a, 1b, 1c, and 1d uniformly.

[0053] The photoconductor unit 22 is laid out so that at least each of photoconductors 1a, 1b, 1c, and 1d is supported by two supports 110a and 110b, as shown in Figure 2 (c). Holders to hold these supports 110a and 110b are provided on the side of enclosure 200. Photoconductors 1a, 1b, 1c, and 1d are configured as one unit.

[0054] Accuracy adjustment at the time of manufacturing allows layout to ensure that the space and parallelism among photoconductors 1a, 1b, 1c, and 1d are highly accurate.

[0055] Furthermore, when the user wants to replace the photoconductors, he can replace one photoconductor unit 22 integrating the photoconductors 1a, 1b, 1c, and 1d. This ensures a stable space and parallelism among photoconductors. In this configuration, photoconductors 1a, 1b, 1c, and 1d are replaced, mounted and dismounted as a photoconductor unit 22. The layout position of photoconductor unit 22 may be changed from the specified position, but photoconductors 1a, 1b, 1c, and 1d inside the photoconductor unit 22 maintains the specified space and are parallel with one another. This eliminates the possibility of the photoconductor layout position being changed, and ensures easy image registration. The distance among photoconductor in the vertical and lateral directions remains unchanged and ensure easy replacement of photoconductors, thereby improving maintainability.

[0056] When such peripheral devices as as charging devices 3a, 3b, 3c and 3d related to multiple photoconductor 1a, 1b, 1c,,1d, together with multiple photoconductors, are integrated into one unit, more stable,·high quality and high definition image recording can be ensured without sacrificing maintainability.

[0057] The following describes the how to drive the multiple photoconductors 1a, 1b, 1c, and 1d (Figure 2 (c) and (d)).

[0058] The photoconductor can be driven either by using the same speed for all photoconductors 1a, 1b, 1c, and 1d, or by using different speeds for them.

[0059] If the variations of diameters of photoconductors 1a, 1b, 1c, and 1d can be reduced, all photoconductors are driven at the same speed.

[0060] Photoconductors 1a, 1b, 1c, and 1d is provided with a photoconductor drive gear 100 to rotate and drive shafts for connection with supports 110a and 110b. These photoconductor 1a, 1b, 1c, and 1d are driven by one gear from the side of the main unit (outside the photoconductor unit, on the side enclosure 200). A discharged toner collector drive gear 101 is provided to drive the discharged tone collectors 7a, 7b, 7c and 7d at the same time. A discharged toner outlet path 102 to remove discharged toner is provided on the side opposite to the photoconductor drive gear 100, namely, on the side of the support 110a.

[0061] The connection gears to drive the photoconductors 1a, 1b, 1c, and 1d can be laid out on the side of the main unit to drive the photoconductors 1a, 1b, 1c, and 1d by four gears from the side of the main unit. In this case, assuming that photoconductor unit 22 is mounted and dismounted over the photoconductor drive gear 100 to drive the photoconductors 1a, 1b, 1c, and 1d, the gear of the main unit and photoconductor drive gear 100 are laid out at a little offset position so that they do not interfere when the photoconductor unit 22 is mounted and dismounted.

[0062] Photoconductors 1a, 1b, 1c, and 1d can be connected by belts without using gears as in the above case.

[0063] If the photoconductors 1a, 1b, 1c, and 1d are driven at the same speed when there are big variations in the diameters of multiple photoconductors 1a, 1b, 1c, and 1d, differences in peripheral speeds will occur among photoconductors, and image misregistration and slip will occur. These differences in peripheral speeds can be reduced by driving each of photoconductors 1a, 1b, 1c, and 1d independently. Image registration accuracy can be improved by installing a motor to drive each

of photoconductors 1a, 1b, 1c, and 1d, and by compensating the differences in peripheral speeds of photoconductors 1a, 1b, 1c, and 1d caused by variations in diameters of photoconductors 1a, 1b, 1c, and 1d; this will ensure high picture quality. In this case, to prevent deflection of the intermediate transfer belt 2 among photoconductors 1a, 1b, 1c, and 1d, the drive speed of the photoconductor 1d located downstream in the direction of the movement of intermediate transfer belt 2 can be made faster than that of the photoconductor 1a located upstream.

[0064] If the friction load of development devices 5a, 5b, 5c and 5d and photoconductor cleaners 6a, 6b, 6c and 6d can be reduced, photoconductors 1a, 1b, 1c, and 1d can be made to follow the intermediate transfer belt 2, without applying driving force to photoconductors 1a, 1b, 1c, and 1d. In this case, the peripheral speed of each of photoconductors 1a, 1b, 1c, and 1d can be matched to the speed of intermediate transfer belt 2. This allows easy registration of toner particles of different colors. To ensure that the drive force of the intermediate transfer belt 2 is transmitted to the photoconductors 1a, 1b, 1c, and 1d in this case, a component to increase the friction coefficient may be placed on the surface of the intermediate transfer belt 2; for example, rubber or such high friction materials can be placed in the non-printing area of the intermediate transfer belt 2 or photoconductor 1.

[0065] To prevent deflection from occurring to the belt surface in contact as described above, the intermediate transfer belt 2, photoconductors 1a, 1b, 1c, and 1d is located at the photoconductor pulling position, and drives the belt tension roller 10b laid out below the photoconductor 1d. This belt tension roller 10b has a rubber or other frictional layer on the roller surface to prevent the belt and roller from slipping, as described above, belt deflection can be prevented by increasing the speed of intermediate transfer belt 2 by a slight change of the peripheral speed of photoconductors 1a, 1b, 1c, and 1d and the speed of intermediate transfer belt 2. The intermediate transfer belt 2 can be driven in the following manner by applying tension to the belt: The deflection of intermediate transfer belt 2 on the surface where photoconductors are arranged can be reduced by giving tension to the belt at the component as a rotational load for the intermediate transfer belt 2, namely, at the surface of the intermediate transfer belt 2 on the photoconductor side where the transfer device 13 (Figure 1) and intermediate transfer belt cleaner 15 are in contact with each other, in the present embodiment. The belt may be driven by the belt tension rollers 10a, 10c and 10d by giving the tension of the intermediate transfer belt 2 using the belt tension rollers 10a and 10b or another component provided on the side of the photoconductor. For example, when tension is given to the belt by the belt tension roller 10b to drive belt tension roller 10a, the surface of the belt where photoconductors are laid out is always kept pulled, so deflection does not occur.

[0066] Furthermore, if it is possible to reduce the contact load of intermediate transfer belt cleaner 15, the photoconductor can be made to follow the intermediate transfer belt 2. In this case, the photoconductors 1a, 1b, 1c, and 1d is made to follow the intermediate transfer belt 2 as described above, and their surface speeds become the same, thereby ensuring easy registration of the images of different colors.

[0067] When the speed of photoconductors 1a, 1b, 1c, and 1d and intermediate transfer belt 2 is to be made variable, they are driven by the motor such as pulse motor or servo motor which permits speed control.

[0068] The following describes the driving method in other major processes.

[0069] In the present embodiment, the charging rollers shown in Figures 1 and 2 are used as charging devices 3a, 3b, 3c and 3d. To simplify configuration around the photoconductor, the charging roller is driven by photoconductors 1a, 1b, 1c, and 1d. However, drive power can be supplied from the photoconductor and other drive mechanism if a sufficient friction with the photoconductor cannot be obtained because the charging roller having a larger diameter is used to prolong service life, or a highly lubricating surface layer on the surface of the charging roller is formed to prevent toner from depositing.

[0070] As shown in Figure 5, each of the development devices 5a, 5b, 5c and 5d is designed as a unit capable of being mounted and dismounted independently. Power is separately transmitted to each of development devices 5a, 5b, 5c and 5d. In the present embodiment, development device drive motor power is branched off into four parts on the main unit side to drive each development device. Each development device can also be driven by each photoconductor.

[0071] In the image forming system based on nonmagnetic one-component development method as shown in Figure 11, the volume of toner deposited can be adjusted by changing the speed of the development roller 37. So in order to adjust the deposited toner volumes of different colors, it is possible to give differences to the speeds of development devices 5a, 5b, 5c and 5d for different colors by driving each of the development devices 5a, 5b, 5c and 5d by a separate motor.

[0072] In the embodiment shown in Figure 1, a transfer roller is used as a transfer device 13. To simply mechanism, this transfer roller is made to follow the intermediate transfer belt 2, but it can also be driven when the transfer roller gives a big rotational load to the intermediate transfer belt 2.

[0073] The following describes the image forming system according to an embodiment of a printing sequence, with reference to Figures 1 and 3.

[0074] When the print command is sent to the controller (not illustrated), the drive of intermediate transfer belt 2, and drive and electrostatic charging of photocon-

ductor 1a, 1b, 1c, and 1d are started. Then the photoconductor 1a in contact with the intermediate transfer belt 2 is subjected to image exposure by the exposure device 4a, and electrostatic latent image is formed on the photoconductor 1a. Then the electrostatic latent image is developed by the development device 5a, and toner image is formed on the photoconductor 1a. At the same time, toner image is transferred on the intermediate transfer belt 2. Almost at the same time, image exposure is performed on the photoconductor 1b located immediately below, and toner image is formed by the development device 5b. Start of exposure of this photoconductor 1b is timed to ensure that toner image formed on the photoconductor 1b can be accurately superimposed on the image previously formed by the photoconductor 1a on the intermediate transfer belt 2. In this process, an image with two color toner images superimposed is formed on the intermediate transfer belt 2. Similarly, exposure, development and transfer are carried out on the 3rd and 4th color photoconductors 1c, and 1d, and full color image is formed after toner images of different colors are superimposed on the intermediate transfer belt 2. The full color image on the intermediate transfer belt 2 is transferred onto the paper or other recording medium which has been fed from the form cassette 16 by the transfer device 13, and is fused by the fusing device 19. Paper is then discharged from above the enclosure 200. To record a high picture quality full color image in the present embodiment, four-color toner is used to get the full color image recording. Full color image recording can also be obtained by the toner of three colors; yellow, mazenta and cyan. The number of printing processes using the photoconductor and development device can be three.

[0075] The color image forming system based on electrophotographic technology forms a color image by superimposing toner of different colors.

[0076] The image forming system according to the present embodiment is based on the simultaneous printing method where four photoconductors corresponding to the toner colors of yellow, mazenta, cyan and black are used, and images are formed almost at the same time.

[0077] The following further describes the layout relationship of the image forming system including the photoconductor and intermediate transfer device according to the present embodiment as shown in Figure 1. The description refers particularly to the belt-formed intermediate transfer device.

[0078] In the image forming system according to the present embodiment, the toner images of different colors formed on the photoconductors 1a, 1b, 1c, and 1d have been superimposed on the intermediate transfer device. Then these images are transferred to the final recording medium such as paper collectively. This does not required the photoconductor unit 22 and fusing device 19 to be arranged on the same line. In the image forming system shown in Figure 1, an intermediate transfer belt 2 is arranged between the photoconductor unit 22 and fusing device 19. This saves the space because it improves the layout configuration where the system is laid out in a slender form in the direction where photoconductors are laid out.

[0079] The entire system can be made compact by stretching the intermediate transfer belt 2 so that the cross section of the entire belt is reduced. Furthermore, the exposure devices 4a, 4b, 4c and 4d and development devices 5a, 5b, 5c and 5d which respectively expose and develop the photoconductor 1 are stacked and laid out in the longitudinal direction. Increase in the size of these components causes the system dimensions, especially the height, to be increased. In the present embodiment, the dimension of the exposure devices 4a, 4b, 4c and 4d and development devices 5a, 5b, 5c and 5d in the direction of height is made smaller that in the horizontal direction, thereby making the entire system compact in configuration.

[0080] In the present embodiment, photoconductors 1a, 1b, 1c, and 1d are laid out almost in a line in the longitudinal direction. The intermediate transfer belt 2 is laid out generally in the horizontal direction with respect to the direction where photoconductors 1a, 1b, 1c, and 1d are laid out. The surface of the intermediate transfer belt 2 on the side of photoconductors is flattened to ensure safety of belt traveling which is crucial when superimposing toner images formed by the photoconductors 1a, 1b, 1c, and 1d. At the same time, the process parts around the photoconductors 1a, 1b, 1c, and 1d are made to have the same size for parts standardization, thereby ensuring lower parts cost and easy adjustment of printing conditions.

[0081] As described above, photoconductor unit 22 equipped with photoconductors 1a, 1b, 1c, and 1d is laid out in the longitudinal direction in the present embodiment in the present embodiment. The photoconductor unit 22, intermediate transfer belt 2 and fusing device 19 are laid out in the lateral direction (perpendicular to the direction of gravity). Adoption of the above-mentioned layout configuration allows transfer device 13 and fusing device 19 to be laid out close to the outer surface of the system. It also allows the paper feed path to be arranged along the outer surface of the main unit, Consequently, even when paper jamming has occurred and paper remains inside the main unit, paper can be easily removed by opening the back of the enclosure 200 (on the side where the transfer device is installed). For example, when paper jamming has occurred during the feed of the recording medium between the photoconductors and transfer belt, each photoconductor and transfer belt must be removed in order to remove the recording medium remaining in the system. This will involve very complicated procedures.

[0082] The following uses Figure 5 to describe one embodiment of the replacement method for the process parts including the photoconductor unit 22 and development devices 5a, 5b, 5c and 5d of the image forming

system according to the present embodiment, and the mechanism of opening various parts of the enclosure.

[0083] As described above, surface wear and deterioration occur to photoconductors as printing is repeated; then photoconductors must be replaced. The development devices must also be replaced as the toner is consumed. To ensure excessively maintainability, easy replacement of consumables including these photoconductors and development devices is very important.

[0084] In the present embodiment, the photoconductor unit 22 integrating the photoconductors 1a, 1b, 1c, and 1d is designed to be mounted and dismounted in the direction where photoconductors 1a, 1b, 1c, and 1d are laid out, namely, in the longitudinal direction. In the embodiment shown in Figure 1, the photoconductor unit 22 long in the longitudinal direction is arranged between the exposure devices 4a, 4b, 4c and 4d fixed to the enclosure of the main unit and intermediate transfer belt 2. Adoption of the above configuration ensures easy replacement.

[0085] In the image forming system according to the present embodiment, furthermore, development devices 5a, 5b, 5c, 5d for different colors are laid out laid out along the photoconductor unit 22 vertically with respect to the direction where the photoconductor unit 22 is laid out (a little obliquely in the longitudinal or lateral direction). It is designed to be mount and dismounted by sliding in the lateral direction, namely, vertically with respect to the direction where photoconductor unit 22 is laid out. In the present embodiment, development devices 5a, 5b, 5c and 5d are laid out among exposure devices 4a, 4b, 4c and 4d fixed to the enclosure 200 of the main unit, and are laid out alternately photoconductor unit 22. This configuration ensures easy replacement and reduces the operator's loads when replacing the consumables.

[0086] Furthermore, charging devices 3a, 3b, 3c and 3d, and photoconductor cleaners 6a, 6b, 6c and 6d are replaceable since they are contaminated due to deposition of toner in the printing process. In the image forming system according to the present embodiment, photoconductor cleaners 6a, 6b, 6c and 6d is laid out inside the photoconductor unit 22, as shown in Figure 2, and can be replaced simultaneously with photoconductor unit 22. In this case, charging devices 3a, 3b, 3c and 3d and photoconductor cleaners 6a, 6b, 6c and 6d themselves may be configured as a unit to facilitate mounting and dismounting from the photoconductor unit 22.

[0087] The photoconductors 1a, 1b, 1c, and 1d is laid out fixed inside the photoconductor unit 22, so all photoconductors are replaced when the photoconductor unit 22 is replaced. However, when printing is performed by using the mechanism which connects and disconnects photoconductors 1a, 1b, 1c, and 1d and intermediate transfer belt 2 as described above, and by using only the photoconductor of the toner required for printing, the degree of wear and deterioration will be different for each photoconductor. If the configuration to allow simultaneous replacement of all photoconductors in this case, replacement of the photoconductor unit 22 will be determined by the photoconductor which has been most frequently used. This will mean a waste of other photoconductors which have been used less frequently. In this case, it is possible to allow each photoconductor to be mounted and dismounted from the photoconductor unit 22, so that each photoconductor can be replaced in conformity to the number of sheets.

[0088] To ensure accurate registration of toner image of different colors, exposure devices 4a, 4b, 4c and 4d is directly fixed to the enclosure 200. Other configuration applicable to the image forming system according to the present embodiment is that each exposure device is fixed by the exposure fixing component, and the exposure unit fixing and laying out four exposure devices 4a, 4b, 4c and 4d is fixed to the enclosure 200 of the main unit. Exposure devices 4a, 4b, 4c and 4d are not replaced as consumables, but easy system adjustment can be ensured by adopting the configuration which allows mounting and dismounting from the main unit.

[0089] The erase lamps 8a, 8b, 8c and 8d can be laid out fixed to the enclosure of the main unit or can be arranged inside photoconductor unit 22.

[0090] In the present embodiment, the service life of intermediate transfer belt 2 is the same as that of the main unit.

[0091] So the belt tension rollers 10a, 10b, 10c and 10d are fixed to the enclosure 200. However, they may be scratched or damaged due to user operation error and others, and may have to be replaced. Therefore, the intermediate transfer belt 2 cab be designed in a unit to permit replacement.

[0092] The intermediate transfer belt cleaner 15 is not replaced in the image forming system according to the present embodiment, and is fixed to the enclosure of the main unit. It goes without saying that the intermediate transfer belt cleaner 15 can be designed into a unit to allow replacement, as described above, the intermediate transfer belt unit cleaner 15 can be laid out in the intermediate transfer belt unit to permit simultaneous replacement with the intermediate transfer belt 2.

[0093] The transfer device 13 is contaminated by toner and paper powder. If the transfer performance is greatly affected by this contamination, it is possible to design the transfer device 13 so that it can be replaced.

[0094] The fusing device 19 has a high temperature, and a great variety of types of recording media are passed through it. This makes it difficult to maintain the fusing performance high. So in the image forming system according to the present embodiment, the fusing device 19 is designed as a unit which can be replaced. It goes without saying that, when the oil application mechanism (Figure 16) to apply silicone and other oil is used to improve fusing performance, or cleaning mech-

anism 84 to clean the fusing roller surface is provided, each of them can be laid out as a separate unit on the fusing device 19 to permit replacement.

[0095] Highly accurate registration of the toner image formed on the multiple photoconductors 1a, 1b, 1c, and 1d is essential. The image forming system shown in Figure 1 is designed in such a way that the side plate is used to hold the process in-between from both ends in the axial direction. This configuration ensures that layout positions for photoconductor unit 22, exposure devices 4a, 4b, 4c and 4d, and a belt tensioning roller to stretch the intermediate transfer belt 2 can be determined accurately by the side plate.

[0096] Consequently, the process can be mounted and dismounted in the vertical or lateral direction in Figure 5 when each process is to be replaced.

[0097] A top cover which can be opened and closed is provided on the surface of enclosure 200. Photoconductor unit 22 and fusing device 19 are replaced by releasing this cover and pulling out upward in the longitudinal direction. Furthermore, a cover which can be opened and closed to replace the development devices 5a, 5b, 5c and 5d is provided on the right of the main unit shown in Figure 6. Since development devices 5a, 5b, 5c and 5d are required to bring the development roll in contact with with the photoconductor, load must be applied to the side of photoconductors 1a, 1b, 1c, and 1d. In the image forming system according to the present embodiment, the development device is pressed against the cover to be opened to replace the development devices 5a, 5b, 5c and 5d, and the component is mounted. When the door is closed, the development device is pushed inside with an appropriate load.

[0098] A door to remove the recording medium is installed on the left of the main unit shown in Figure 6. According to the present embodiment, the paper feed path is laid out generally in the vertical direction so that it does not make a abrupt turn along the outer surface of the main unit. This prevents the recording medium from being bent. This method is applicable to a great variety of paper including cardboards. At the same time, it ensures easy removal of the recording medium.

[0099] The form cassette 16 to supply paper is designed to be inserted or removed from the from the right side of the main unit.

[0100] According to the present embodiment as shown in Figure 5, each process is held in-between by the side plate. For example, it is possible that an opening is provided on the side plate with respect to the direction where the recording medium is discharged, and each process unit is replaced through that opening. In this case, photoconductor unit 22 and development devices 5a, 5b, 5c and 5d are each mounted or dismounted in the axial direction of the rotary shaft.

[0101] The following describes the detailed configuration of each process:

[0102] In the image forming system shown in Figure 1, in order to ensure that the printing speed in the color print mode is the same as that of a monochrome printer, the process speed -- the traveling speed of the photoconductor, intermediate transfer belt and recording medium -- is set at 100 mm/s (100 mm/sec.), as discussed above. If the process speed is set to 100 mm/s, the printing speed of about 16PPM and 24PPM is obtained when the A4 paper is fed in the in the longitudinal or lateral direction, even if consideration is given to the space between sheets of paper. This makes it possible to get the speed equivalent to that of the current monochrome printer.

[0103] Each of photoconductors 1a, 1b, 1c, and 1d used in the image forming system shown in Figure 1 is a drum-formed photoconductor having the same diameter. It has a organic photosensitive layer provided on the surface of the aluminum cylindrical tube. It goes without saying that inorganic photoconductor such as amorphous silicone photoconductor can be used as photoconductors. Use of the drum-formed rigid body as photoconductors 1a, 1b, 1c, and 1d makes it possible to stabilize the photoconductor surface speed important for registration of the toner images formed on the photoconductors of different colors. Furthermore, use of the drum of the same diameter reduces the parts cost.

[0104] The following describes the diameter of the photoconductors 1a, 1b, 1c, and 1d: The entire system can be designed in a more compact configuration when the diameter of the photoconductor is smaller. However, the potential on the surface of the photoconductor requires a long response time from irradiation of light to damping. Response time varies according to the sensitivity of the photoconductor. The response time of the organic photoconductor offered at lower costs at present is about 0.1 to 0.2 sec. So distance between the exposure point on the photoconductor where the light of the exposure device is applied and the development point where development device develops the photoconductor must be about 10 mm to 20 mm, since the process speed is 100 mm/s in the image forming system shown in Figure 1. With consideration given to this response speed and the layout of the process such as charging device and photoconductor cleaners around the photoconductor, the photoconductor diameter has been studied. This study has revealed that 40 mm or more is necessary. If the photoconductor is 40 mm or less, the distance between exposure and development points cannot be ensured, and response of the photoconductor is insufficient. Based on this study, the photoconductor diameter is set at 40mm in the present embodiment. It goes without saying that, when there is an improvement in the photoconductor sensitivity, photoconductors of smaller diameter, for example, a diameter of about 30 mm, may be used.

[0105] When higher speed printing is important, photoconductor diameter must be increased.

[0106] Furthermore, belt-formed photoconductors can be used. Use of belt-formed photoconductors involves two problems; the belt offset must be avoided,

and the structure is more complicated than that of the drum formed photoconductors. However, the belt tensioning method allows the photoconductor layout space to be reduced, and provides an increased allowance for the layout of processes around the photoconductor. This allows more compact configuration that the space around the photoconductor

[0107] Charging devices 3a, 3b, 3c and 3d used in the present embodiment charge the photoconductor 1 by utilizing the charging roller to which bias voltage applied. The charging roller has a charging roller elastic layer formed on the charging roller metallic shaft, and has a charging roller surface layer formed thereon. To change the photoconductor uniformly using the charging roller, it is essential to ensure contact between charging roller and photoconductor. For this purpose, the charging roller is designed to cover the charging roller metallic shaft surface with the charging roller elastic layer formed of rubber materials such as solid rubber and sponge rubber. At the same time, it provides contact with the photoconductor with adequate loads in order to ensure formation of a stable nip. Furthermore, the rubber material of the charging roller elastic layer is made conductive or semi-conductive. As a result, bias voltage applied to the charging roller metallic shaft is effectively applied to the photoconductor, thereby improving charging reliability. A charging roller surface layer of fluorine resin or the like is provided on the surface in order to prevent the plasticizer contained in the rubber material of the charging roller elastic layer from degenerating the toner and photoconductor, to ensure longer service life of the charging roller 23 and to improve toner releasing performances.

[0108] The charging roller of the charging devices 3a, 3b, 3c and 3d of the image forming system shown in Figure 1 has a charging roller elastic layer of urethane sponge rubber having a thickness of 2 mm provided on the charging roller metallic shaft having a diameter of 5 mm, and a charging roller surface layer as a fluorine resin tube is provided on the surface. Therefore, the diameter as a charging roller is as small as about 9 mm, but a sponge rubber is used for charging roller elastic layer 25. This ensures an excellent contact with photoconductors. Use of such a small-diameter charging roller permits an allowance to be given to process layout around the photoconductor.

[0109] The resistance on these charging roller elastic layers and surface layer is as low as about 10 kilohms cm. This allows photoconductors to be charged at a low voltage. Furthermore, the image forming system according to the present embodiment allows use of a corona charging device in addition to the charging device 3.

[0110] The corona charging device has a corona wire laid out inside the shield case provided at the opening. A high pressure is applied to wire to generate corona discharge. Electrical charge discharged from the opening is irradiated on the photoconductor to charge the photoconductor 1. In order to stabilize charged potential of the photoconductor, the opening can be equipped with a grid to which a specified voltage is applied. In the corona charging device, spark discharge will occur and discharge will become unstable if the distance between the wire and shield case is small. Namely, the distance between the wire and shield case cannot be made smaller. So the size of the entire charging device tends to be greater than the charging roller as discussed above. However, the corona charging device allows charging without direct contact with the photoconductor. This makes it possible to prolong the service life of the charging device. If the longer service life is more important, the corona charging device can be used.

[0111] Figure 6 shows an embodiment of the exposure device 4a of the image forming system according to the present embodiment. The same also applies to other exposure devices 4b, 4c and 4d.

[0112] In offices, recent progress of computers has made it possible to handle photographic image as well as text. To catch up with this trend, the image forming system shown in Figure 1 has a printing density (resolution) of 600 dpi (dots/inch). In the image forming system based on electrophotographic technology, high quality recording of photographic image requires at least 300dpi. The image forming system according to the present embodiment has a printing density of 600 dpi; this meets the requirements sufficiently.

[0113] The present embodiment uses a laser exposure device comprising semiconductor laser 27, polygon mirror 28, polygon motor 29 and Fθ lens 30.

[0114] The laser exposure device shown in Figure 6 uses the laser beams of the semiconductor laser 27 to reflect and scan it by the polygon mirror 28. The Fθ lens 30 is used to correct the differences of focal distances resulting from the differences of the optical paths leading to the photoconductors to be exposed, and the fluctuations of the traveling distance on the scanned surface per unit rotary angle of polygon mirror 28. To ensure the laser scanning width of the recorded image width, a long optical path must be provided in the space from the polygon mirror 28 to the photoconductor. If the scanning angle of the polygon mirror 28 is reduced, a stable volume of exposure can be gained in the scanning direction since the volume of correction by Fθ lens 30 is small. At the same time, the number of polygon mirrors 28 can be increased, thereby allowing high speeding printing. However, a small scanning angle requires the distance form the polygon mirror 28 to the photoconductor to be increased. This results in an increased size of entire laser exposure device. To ensure the printing speed on the level of the monochrome printer speed, the present embodiment uses a hexahedral polygon mirror which is generally used in the monochrome printer.

[0115] To ensure stable rotation, the polygon motor 29 to rotate the polygon mirror 28 is preferred to be laid

out to ensure that the polygon mirror 28 is rotated horizontally with respect to the direction of gravity. In this case, the height of the exposure device cannot be made smaller than that of the polygon motor 29 to rotate the polygon mirror 28 plus the space of Fθ lens 30 located above the laser scanning surface. In the image forming system shown in Figure 1, the process speed is 100 mm/s. To get the printing density of 600 dpi, hexahedral polygon mirror 28 must be driven at a rate of about 24,000 rotations one second. Currently, the height required by the polygon motor 29 rotating at this speed is about 20 mm. The height of the Fθt lens 30 must be about 10 mm in order to ensure production stability. Therefore, the maximum possible height for the current laser exposure device is about 30 mm. The laser exposure device according to the present embodiment provides horizontal rotation of the polygon mirror 28. To minimize the entire laser exposure device, the laser beam reflected by polygon mirror 28 has passed through Fθ lens 3 is reflected by the folding mirror 31 after it has passed through Fθ lens 30, as shown in Figure 6, and exposes the photoconductor 1a laid out in an upward slanting direction.

[0116] Furthermore, in the configuration shown in Figure 6, the upper and lower portions of the exposure device are flat to ensure easy replacement of the development device laid out between exposure devices.

[0117] The exposure device shown in Figure 6 is designed to minimize the height, so that the exposure device can be about 30 mm high.

[0118] When the number of polygon mirrors 28 is increased in order to increase the printing speed or the printing width is increased to be compatible with a greater paper size, it is essential to increase the length of the optical path, as discussed above. In this case, the folding mirror 31 inside the laser exposure device must be laid out so that the length of the optical path can be increased. Figure 7 shows an example of the laser exposure devices where their lower portions are made convex and part of the folding mirror 31 is laid out in order to increase the length of the optical path. Since the lower portions of the exposure devices 4a, 4b, 4c and 4d are made convex, the length of the optical path can be made greater than that of the laser exposure device. The height of the exposure device is greater than that shown in Figure 6. When the laser exposure device shown in Figure 7 is used in the image forming system shown in Figure 6, the convex portions are arranged on photoconductors 1a, 1b, 1c, and 1d of exposure devices 4a, 4b, 4c and 4d; namely, the folding mirror 31 is laid out on the side of photoconductors 1a, 1b, 1c, and 1d of exposure devices 4a, 4b, 4c and 4d.

[0119] At the same time, projections and depressions are created on development devices 5a, 5b, 5c and 5d laid out above and below the exposure devices 4a, 4b, 4c and 4d in conformity to the convex form of exposure devices 4a, 4b, 4c and 4d. This makes it possible to make an effective use of the space inside the system. This slightly increases the size of the entire system, but the toner storage volume inside development devices 5a, 5b, 5c and 5d can be increased by changing the outside shape of the development devices 5a, 5b, 5c and 5d, namely, by increasing the size of the development device. At the same time, replacement of development devices 5a, 5b, 5c and 5d is as easy as that in Figure 5, since the convex portion of the exposure devices 4a, 4b, 4c and 4d is installed on the photoconductors 1a, 1b, 1c, and 1d.

[0120] To reduce the size of the entire system, it is effective to reduce the height of the exposure device. The height of exposure devices 4a, 4b, 4c and 4d is determined by the height in the space securing the height of the polygon motor 29 and the size of Fθ lens 30.

[0121] Of these, the polygon motor 29 requires that the mechanism such as bearing or the like be provided in the axial direction in order to ensure a stable rotation. This makes it very difficult to work out a thin configuration. The embodiment given in Figure 8 shows that the polygon mirror 28 and polygon motor 29 are installed inside the main unit, namely, the polygon mirror 28 and polygon motor 29 are installed outside the portion laminated with development devices 5a (5b, 5c and 5d) indicated by the dotted line. In the portion laminated with development device 5 according this configuration, only the Fθ lens 30 and folding mirror 31 to reflect the laser beam are laid out inside the exposure devices 4a (4b, 4c and 4d), so the height can be reduced. To work out an optical system like this, the structure of Fθ lens 30 must be improved, but this is effective in reducing the system size.

[0122] A Fθ mirror having Fθ characteristics may be used instead of the Fθ lens 30 and folding mirror 31.

[0123] When images are formed using the different multiple laser exposure devices and are superimposed to form a final image, it is essential to minimize the distortion and deformation of the polygon mirror, Fθ lens and folding mirror 31. However, increased accuracy of such optical parts involves very high costs, so errors in distortion and deformation of parts are present in practice, and different distortions occur to the images exposed by exposure devices. To solve this problem, in the image forming system according to the present embodiment, parts having similar distortion and deformation are combined in advance to constitute four exposure devices, which are built in the main unit. Distortions of the images of exposure devices are made uniform by the combination of such parts, thereby preventing image misregistration. When combination of such parts is used, it is possible to provide a mechanism to adjust the optical parts position such as a Fθ lens position adjustment mechanism.

[0124] The following can be also be used as other embodiments of the exposure devices:

[0125] Figure 9 shows an embodiment where LED array 32 is applied to the exposure devices 4a, 4b, 4c

and 4d of the image forming system according to the present embodiment. The exposure devices of the LED array 32 exposes the photoconductor by the same number of LEDs arranged as that of the print dots of the image width. It allows exposure devices to be designed in smaller configuration without requiring a long optical path as in the case of the laser exposure devices as discussed above. The LEDs corresponding to respective dots emit light independently, and this will provide a high speed easily.

[0126] The LED array exposure device comprises a required number of LED arrays 32 arranged in a line, a drive circuit 33 to drive them, and a lens 34 to form on the photoconductor an image of the light emitted from the LED array 32. The number of LEDs for exposure at the printing density of 600dpi is 600 per inch, namely, 230 to 240 per centimeter. When A4 paper is fed in the longitudinal direction, the required printing width is 21cm or more. So about 5400 to 6000 LEDs are required. When A4 paper is fed in the lateral direction, the required printing width is 30 cm or more, requiring about 7000 to 9000 LEDs. These LED arrays 32 and driver circuit 33 are created using a semiconductor process.

[0127] The LED array exposure device requires a great number of LEDs to be driven independently. Installation of a driver circuit outside the exposure device makes wiring or the like complicated, and is not practical.

[0128] To solve this problem, the image forming system according to the present embodiment has LED array 32 formed on the same chip where LED array 32 is formed to ensure easy interface with the outside. A circuit to correct the variations of the light emitting luminance of each LED and a circuit to enable gradation output can be mounted on this chip in order to make light emitting luminance of each LED uniform. These LED array 32 and driver circuit 33 are made into chips in units of hundreds to thousands to improve mass production and yield. Scores of chips are combined to secure printing width. If the alignment between LED chips is not accurate in this case, contrast of images between chips occurs. If alignment is different for each LED array exposure device which exposes each photoconductor, accurate registration of toner images of different colors cannot be ensured.

[0129] This requires the alignment among chips not be exceed one dot (42 microns or less at 600dpi).

[0130] In the present embodiment, lens 34 is arranged to ensure that the light emitted by LED forms an image on the photoconductor 1. Rod lens eyes are used.

[0131] Figure 10 shows that LED array exposure device is arranged as exposure device 4a on the photoconductor 1a. This also applies to other exposure devices and photoconductors

[0132] In the image forming system according to the present embodiment, the processes around the photoconductor 1a are laid out mainly on the lower portion of the photoconductor 1a. Layout allowance of each process around the photoconductor can be increased by the exposure device 4a laid out away from the main unit. To make this possible, it effective to increase length of the lens of the LED array exposure device, for example, to about 10 to 30 mm in the image forming system shown in Figure 1, or to prolong the focal distance of the lens, for example, to about 10 to 50mm in the image forming system shown in Figure 1.

[0133] Another embodiment of exposure devices is that a long-focused lens is used and a folding mirror 31 is installed to expose the photoconductor. In this arrangement, LED array exposure devices are arranged away form the photoconductor 1a. This arrangement gives allowance to the process layout around the photoconductor.

[0134] Figure 11 is a cross sectional view of the development devices 5a, 5b, 5c and 5d used in the present embodiment.

[0135] The development devices 5a (5b, 5c and 5d) comprise a development unit 35 to develop latent images on the surface of photoconductors 1a (1b, 1c, and 1d) and a toner storage unit 36 to store toner. The performance of the development unit 35 deteriorates with printing, and the toner storage unit 36 has toner consumed. They must be replaced in conformity to the number of sheets to be printed. In the present embodiment, the development unit 35 and toner storage unit 36 are integrated on one unit to permit simultaneous replacement. This decreases the frequency of replacement of consumables as well as product costs.

[0136] The development device 5a in the present embodiment reduce the height of the development device 5a by horizontal layout of the development unit 35 and toner storage unit 36, thereby contributing to compact configuration of the entire system.

[0137] The development unit 35 of the development device 5a in the present embodiment uses non-magnetic one-component development method. The non-magnetic one-component development method rubs the toner deposited on the development roller 37 using a blade type component, and forms a thin layer of toner. At the same time, toner is charged to a specified volume of charge. This is a method of developing the electrostatic latent image on the photoconductor 1a by bringing this toner thin layer directly in contact with on the photoconductor 1a, without using a carrier.

[0138] As described above, images are developed by bringing the toner thin layer formed on the surface of the development roller 37 directly in contact with photoconductor 1a. So the electrostatic latent images are developed in sharp images, ensuring high picture quality recording. At the same time, such simple parts as development roller 37 and blade are used for toner charging and layer thickness optimization, thereby permitting reduced size of the development unit 35 and reduced price.

[0139] The development unit 35 comprises a development roller 37, toner control blade 38, reset roller 39, toner deposit blade 40, raking paddle 41 and toner feed paddle 42.

[0140] To ensure firm contact with the drum-formed photoconductor 1a by the rigid body, the development roller 37 is covered with such an elastic body as rubber around the metallic shaft. At the same time, to permit stable transport of the toner, the surface of the development roller 37 is roughened to an appropriate roughness. Bias voltage is applied to the development roller 37 in order to develop toner on the surface of the development roller 37 on the photoconductor 1a. To supply an insufficient amount of toner on the surface of the photoconductor 1a, the surface of the development roller 37 is rotated in the same direction as movement of the surface of the photoconductor. In the present embodiment, the development roller 37 rotates in the upward direction at the position opposite to the photoconductor, and the peripheral speed of the development roller 37 is higher than the photoconductor surface speed. The toner control blade 38 to provide electrostatic charging of toner and to form a specified thin layer of toner on the surface of the development roller 37 is located below the development roller 37. Contact pressure of the toner control blade 38 is important for electrostatic charging and layer pressure control of toner. To ensure stability and uniformity, the image forming system according to the present embodiment uses the metallic thin plate. Furthermore, to ensure that the toner does not stop at the position where the toner control blade 38 is brought in contact with the development roller 37 with the rotation of the development roller 37, a counter is used to bring the toner control blade 38 is made to contact in contact in the rotary direction of the development roller 37. In this case, to avoid excessive raking of the toner deposited on the surface of the development roller, the flat portion of the toner control blade 38 is brought in contact with the development roller 37, without the tip of the toner control blade 38 in contact directly with it. The reset roller 39 removes the toner remaining on the surface of the development roller 37 once without being developed, and deposits a new layer of toner on the surface. It rotates in the same direction as the development roller 37 to provide both raking and supply of tone at the same time. To ensure contact with the development roller 37 and reliable raking and deposition of the toner, the present embodiment uses a roller having the metallic shaft surface covered with sponge. The toner deposit blade 40 is provided to ensure that the tone deposited on the development roller 37 by the reset roller 39 will not fall from the surface of the development roller 37 due to gravity. The raking paddle 41 is provided to ensure that the toner raked off by the toner control blade 38 will not remain close to the blade to solidify and stick there. It rotates in the counterclockwise direction, and toner raked off by the toner control blade 38 is discharged toward the toner storage unit 36.

[0141] The toner feed paddle 42 is installed to feed toner inside the toner storage unit 36 to the reset roller 39. The reset roller 39 is laid out on the top of the development device. To feed toner to this portion, it is necessary to feed toner of the storage unit to the reset roller 39 against the gravity. The toner feed paddle 42 rakes toner of the toner storage chamber up to the portion of the reset roller 39 supply it to the reset roller 39. When the toner feed paddle 42 is used to rake the toner up to the reset roller 39, rotations of both parts are synchronized so that the toner raking paddle 41 is in contact with the toner feed paddle 42, thereby ensuring toner rake-up operation.

[0142] The toner storage unit 36 comprises toner storage chamber 43 and toner supply paddle 44, as shown in Figure 11.

[0143] The volume of toner determined by the number of sheets to be printed is stored in the toner storage chamber 43. One or more toner supply paddles 44 are arranged in the toner storage chamber 43. It feeds toner to the development unit 35 by rotation.

[0144] In the development devices 5a, 5b, 5c and 5d shown in Figure 11 applied to the image forming system, development portion and toner storage unit 36 are arranged in the horizontal direction as described above, so the height of the development devices 5a, 5b, 5c and 5d is bout 40 mm.

[0145] The development device 5a shown in Figure 11 has the development unit 35 and toner storage unit 36 integrated into one unit. If the service life of the development unit 35 can be prolonged, they can be arranged as different components; development unit 35 and toner storage unit 36 as a toner hopper 45. In this case, only the toner hopper 45 is replaced with the development device left in the main unit. The image forming system shown in Figure 1 allows the toner hopper 45 to be placed closer to the outside of the main unit than the development device 5a, thereby ensuring easy replacement.

[0146] Figure 12 shows an embodiment of the development device which permits separation between the development unit 35 and toner hopper 45. The development device 5a shown in Figure 12 uses a development method called 2-component development method. It is composed of a development unit 35 and toner hopper 45. To reduce the height of the development device 5a, they are arranged in the horizontal direction as in Figure 11. The 2-component development method provide electrostatic charging of toner by mixing toner and carrier as magnetic particles, and uses the magnetic force to send the developer deposited on the carrier to the photoconductor surface where development is performed.

[0147] The development unit 35 shown in Figure 12 comprises a magnetic roller 46 inside the development roll, developer feed paddle 47, developer feed paddle 48, agitation paddle 49 and concentration sensor 50.

[0148] The magnetic roller 46 is designed to give magnetic force inside the sleeve, and to feed developer by rotating the sleeve. At the same time, it forms a magnetic brush by developer close to the photoconductor, and develops electrostatic latent image on the photoconductor. The developer feed paddle 47 is provided to supply developer to the magnetic roller 46.

[0149] The developer control blade 48 is provided to ensure an adequate volume of developer deposited on the surface of the magnetic roller 46. It restrict the excessive developer using a blade formed component. The agitation paddle 49 agitates the toner and carrier in the developer to charge the toner, and stabilizes image quality by mixing them sufficiently. The toner concentration sensor 50 is provided to measure the volume of the toner contained in the developer. Using the magnetic force, it measures the bulk density of the developer, thereby detecting toner concentration.

[0150] The toner hopper 45 consists of a toner storage chamber 43, toner supply paddle 44 and toner supply roller 51. Similarly to the example of Figure 11, the volume of toner determined by the number of sheets to be printed is stored in the toner storage chamber 43. The toner supply paddle 44 is provided to feed toner to the toner supply roller. The toner supply roller 51 is designed to send toner to the development unit 35.

[0151] The development device shown in Figure 12 uses the developer feed paddle 48 to feed the developer agitated by the agitation paddle 49 to the surface of the magnetic roller 46. The magnetic roller 46 feeds it, and development is performed by the magnetic brush consisting of toner and carrier formed on the surface. The developer is again is fed back to the agitation paddle 49 where it is agitated.

[0152] When the toner concentration sensor 50 has detected reduction in the concentration of toner in the developer toner is fed from the toner hopper 45 to the development unit 35 and is agitated with carrier by the agitation paddle 49, thereby providing electrostatic charging.

[0153] Compared with the non-magnetic one-component development method, the 2-component development method has a disadvantage of having to provide a toner/carrier agitation mechanism and toner concentration sensor, thereby increasing the size of the development device with complicated structure. Development of toner on the photoconductor is performed by the magnetic brush formed on the surface of the magnet roller by magnetic force. This reduces the load of contact between the photoconductor and development device, and the rotary torque of the photoconductor and development device. This feature easily stabilizes the rotation of the photoconductor which is important for registration of the images of different colors. The development device shown in Figure 12 can be used for image registration.

[0154] In the image forming system shown in Figure 1 as described above, the space between photoconductors is 70 to 75 mm when the height of the exposure devices 4a, 4b, 4c and 4d is about 30 mm, and development devices 5a, 5b, 5c and 5d is about 40 mm, for example. The height of these processes stacked for four colors is about 280 to 300 mm, so the height of the main unit including the height of the form cassette and panel on the top of the main unit s about 500 mm at most. This height is surely accepted in offices.

[0155] With reference to Figure 1, the following describes the structure of the intermediate transfer belt 2 used in the image forming system according to the present embodiment.

[0156] In the intermediate transfer belt 2 according to the present embodiment, the intermediate transfer belt 2 is stretched by the belt tension rollers 10a, 10b, 10c and 10d which consist four rollers. Auxiliary transfer rollers 9a, 9b, 9c and 9d to bring the photoconductors 1a, 1b, 1c, and 1d and intermediate transfer belt 2 in contact with each other are laid out in the space inside the intermediate transfer belt 2.

[0157] The belt tension rollers 10a and 10b are used to stretch the intermediate transfer belt 2 in the longitudinal direction in order to ensure the surface to install the photoconductors 1a, 1b, 1c, and 1d of different colors.

[0158] The belt tension roller 10c is laid out inside the surface opposite to the surface where the photoconductors of the intermediate transfer belt 2 are laid out. A transfer device 13 is located outside this belt tension roller 10c, and serves to transfer the toner image formed on the surface of the intermediate transfer belt 2 to the recording medium. The belt tension roller 10d is located above the belt tension roller 10d. Unlike the other belt tension rollers 10a, 10b, 10c and 10d, it is located outside the intermediate transfer belt 2 so that the intermediate transfer belt 2 is pushed inside from the outside.

[0159] As described above, layout of the belt tension roller 10d ensures the space to install the fusing device 19 and intermediate transfer belt unit cleaner 15 to be laid out above the transfer device 13. At the same time, the sectional area of the intermediate transfer belt 2 can be reduced to increase the system packaging density.

[0160] Furthermore, this belt tension rollers 10c and 10d are installed at the position where the transfer device 13 and fusing device 19 can be installed to ensure that the paper feed path important for paper feed will draw a smooth curve. This makes it possible to handle a great variety of paper ranging from cardboards to envelope and to reduce paper jamming.

[0161] Since the intermediate transfer belt 2 is applied in this way, the peripheral length of the belt is about 200 to 350 mm. If the diameter of the belt tension roller is small, the belt form will conform to, and get accustomed to the curvature radius of the belt tension roller. To avoid this, its diameter is set to about 40 mm. Furthermore, when the photoconductor and belt tension roller are made to have the same diameter, the same

cycle can be given to speed variations resulting from eccentricity of the photoconductor and belt tension roller. This ensures easy registration of images of different colors.

[0162] In the present embodiment, tone images formed by photoconductors 1a, 1b, 1c, and 1d are transferred onto the intermediate transfer belt 2, and are superimposed. This makes it necessary to ensure a stable traveling of the intermediate transfer belt 2, namely, to minimize the variations in belt speed and offset of the belt. Especially the belt offset may damage the belt. Minimizing the offset is important also in ensuring system reliability. It is necessary to use the belt tension rollers 10a, 10b, 10c and 10d to ensure that that the belt is not offset.

[0163] In the image forming system according to the present embodiment, the belt tension roller 10b located on the downstream side of the of the photoconductor 1d is used as a drive shaft, and drive is made to pull the surface of the belt in contact with photoconductors 1a, 1b, 1c, and 1d at all times. This reduces the possibility of slack occurring to the surface of the belt in contact with photoconductors 1a, 1b, 1c, and 1d, thereby ensuring easy registration of the images of different colors. Furthermore, to allow effective transfer, tension is given to the belt, using as an elastic support the drive shaft and the belt tension roller 10d where the process parts such as photoconductors 1a, 1b, 1c, and 1d, and transfer device 13 are not installed in the opposite position.

[0164] Reduction of the offset of the intermediate transfer belt 2 is important to ensure system reliable and high picture quality. Belt offset is produced when the belt receives the force at a right angle to rotary direction due to the variation of the parallelism of the components in contact with intermediate transfer belt 2. Parallel arrangement of these components is difficult at the current machining technological level, so belt offset is unavoidable. To prevent excessive offset of the belt in the image forming system according to the present embodiment, a rib is installed to the belt end, and a tapered belt offset preventive cap is installed at the end of the belt tension roller 10a located inside the intermediate transfer belt 2. When the belt starts to be offset in response to the force at a right angle to rotary direction, the belt and rib contacts the tapered portion of the belt offset preventive cap from the belt at end of the belt tension roller, thereby preventing the offset. The rib uses the resin and rubber materials which have a sufficient thickness and strength to avoid belt offset.

[0165] Similarly, another way to reduce belt offset is to install an inverted tapered belt offset preventive component outside the belt tension roller 10a. In this configuration, the belt end will run onto the belt offset preventive component to control the belt offset if offset occurs to the intermediate transfer belt 2.

[0166] A belt offset correction mechanism can be provided to reduce the excessive belt offset. Figure 13A is a side view and figure 13B is a front view of the belt offset correction mechanism to reduce the force of the offset belt and to give the belt a force to move in the opposite direction when the belt is offset. This arrangement consists of a rotable tapered piece 56 at the end of the belt tension roller 10a, and the rotary force received by this tapered piece 56 is transmitted to the belt tension roller 10d to reduce the tension. When the belt is offset and the rib 53 of the belt comes in contact with the tapered piece 56, the tapered piece 56 receives rotational force due to friction with the rib 53. When the tapered piece 56 receives rotational force, belt stretching roller support component 57 is pulled by the rotation transmission shaft 58 as shown in the drawing, thereby reducing the tension of the belt tension spring 59 located on the side where the belt is offset.

[0167] Then axial imbalance will occur to the belt tension, and the belt is subjected to the force to be offset in the reverse direction, thereby returning the belt to the correct position.

[0168] If a material capable of free extension and contraction such as rubber material is selected as the major material for the intermediate transfer belt 2, accurate registration of the images of different colors cannot be made. To avoid this, the belt material must have elasticity required for the belt with minimum extension and contraction. To meet this requirement, a plastic or metallic belt material is used. It is also possible to combine these materials to form a belt. For example, plastics laminated with metal, or rubber laminated with and plastics can be used. The present embodiment uses a polycarbonate resin belt having a thickness of 0.1 to 0.2 mm.

[0169] The applicable cross section structure of the intermediate transfer belt 2 includes (1) a single layer structure consisting of only the belt base material, (2) a structure of belt base material and belt surface layer, (3) a structure of belt base material and belt back layer, and (4) multiple structures of the belt base material, belt surface layer and belt back layer. The intermediate transfer belt 2 according to the present embodiment uses a single structure where the above-mentioned resin material is a belt base material. However, a belt surface layer made of a thin layer of fluorine resin may be provided in order to optimize the deposition of the toner on the surface, to avoid surface wear and to prevent the belt from being deteriorated by ozone and heat. To increase the belt strength, use of the belt back layer made of a thin metallic belt is also possible. Furthermore, toner transfer largely depends on the surface properties of the intermediate transfer belt 2. When the tone release property on the surface of the intermediate transfer belt 2 is poor, toner will deposit on the intermediate transfer belt 2 mechanically and chemically, image detects such as transfer efficiency and dropout of character thin line will occur. The surface of the intermediate transfer belt 2 is required not to allow easy deposition of toner. To achieve this property, such coated layer as fluorine resin

can be provided on the belt surface. Fine powder such as silica or low-molecular material as wax can be deposited on the surface of the intermediate transfer belt 2 as mold releasing agent.

[0170] One of the general production methods for belt components is to connect the film materials to form a belt. The belt material created according to this production method necessarily contains seams. The seam of the intermediate transfer belt 2 causes contact loads to occur due to the level difference at the portions of photoconductors 1, transfer device 13 and intermediate transfer belt unit cleaner 15 in contact with the intermediate transfer belt 2. This may result in belt speed variation. It is necessary to make sure that a seam does not occur in the print area. To meet these requirements, the image forming system according to the present embodiment uses a seamless belt material as an intermediate transfer belt. For a seamed belt, the level differences of the seamed portion can be crushed by heat or pressure or is reduced by grinding. At the same time, a mechanism can be provided to detect the seam position to ensure that the image formed by photoconductors 1 is not transferred onto the seamed portion.

[0171] The following describes the electric characteristics of the intermediate transfer belt 2:

[0172] Since toner is made of charged particles, electrostatic power is used to transfer toner from the photoconductors 1a, 1b, 1c, and 1d to the intermediate transfer belt 2, and to transfer toner from the intermediate transfer belt 2 to the recording medium. To transfer toner, homopolar or antipolar electrical charge is given to photoconductors 1a, 1b, 1c, and 1d, intermediate transfer belt 2 and the transfer device 13. Tone is transferred by the electric field generated by this charge. Thus, the intermediate transfer belt 2 is required to have a electrical characteristic to permit effective and stable generation of such a transfer electric field.

[0173] Electrical characteristic of the intermediate transfer belt 2 according to the present embodiment is semiconductivity. At the time of transfer, electrical charge is applied to the intermediate transfer belt 2. If the intermediate transfer belt 2 has a high resistance, electrical charge given by each transfer unit remains in the intermediate transfer belt 2, resulting in unstable transfer, uneven discharge or defective images.

[0174] At the point of contact between photoconductors 1a, 1b, 1c, and 1d, and intermediate transfer belt 2, toner is transferred from photoconductors 1 to intermediate transfer belt 2 by applying bias voltage to the auxiliary transfer rollers 9a, 9b, 9c and 9d on the back of intermediate transfer belt 2. In this case, electrical charge is applied to the back of the intermediate transfer belt 2 from auxiliary transfer rollers 9a, 9b, 9c and 9d. Since the intermediate transfer belt 2 moves with the on-going process, the applied electrical charge is mounted on the belt and is moved. When the intermediate transfer belt 2 starts to depart from photoconductors 1a, 1b, 1c, and 1d, there is an abrupt reduction in the space between the photoconductors 1a, 1b, 1c, and 1d and intermediate transfer belt 2. The potential on the intermediate transfer belt rises to start discharging, and uneven electrostatic charge occurs to the toner on the intermediate transfer belt 2. To reduce this, electrical charge on the intermediate transfer belt 2 must be leaked with the rise of potential; namely, the resistance of intermediate transfer belt must be reduced. The capacitance in the space ranges from 100p to 0.1 pF/cm^2. To damp the potential added to this capacitance earlier than the process speed, it is necessary to set the time constant smaller than the process speed, where said time constant is a product between resistance of the intermediate transfer belt 2 in the surface direction and this capacitance. For the intermediate transfer belt 2 to move 1 cm in 0.1 in the image forming system shown in Figure 1 where the process speed is 100 mm/s, the resistance must be 1G to 10Tn or less to ensure that time constant does not exceed that value. In the present embodiment, the belt material resistance must be adjusted to ensure that the resistance will be 0.1GΩ for a width of 1 cm and a length of 1 cm much smaller than this value.

[0175] To stabilize the potential of the intermediate transfer belt 2, a low resistant component can be installed on the rear of the intermediate transfer belt 2. This configuration can be implemented by making the intermediate transfer belt 2 have two layers; resistance layer and conductive layer;

or by reducing surface resistance on the back surface of the intermediate transfer belt 2. Then the back surface of the intermediate transfer belt 2 can be made to have the same potential over the entire circumference of the intermediate transfer belt 2. If the resistance layer has a high resistance in this configuration, electrical charge applied to the transfer unit remains on the surface of the intermediate transfer belt 2 and accumulates there. It is necessary to install a semiconductive resistance layer, similarly to the case described above. To prevent electrical charge from remaining on the intermediate transfer belt 2, it is necessary to select the resistance of each transfer unit so that the electrical charge will be damped during the movement of the intermediate transfer belt 2. In the image forming system according to the present embodiment, the surface speed of the intermediate transfer belt 2 is 100 mm/s, and the distance between each transfer unit and toner charging device 11 is only several centimeters. So it is sufficient to select the material where the time constant as a product between resistance of the resistance layer of the intermediate transfer belt 2 and the capacitance is equal to or smaller than the time required to travel through various portions which is hundreds ms. This configuration involves a complicated structure of the intermediate transfer belt 2, but provides a stable potential of each portion. So ensures easy transfer control at each portion.

[0176] Furthermore, the same potential can be

given to the entire intermediate transfer belt 2 over the entire circumference even if the resistance of the intermediate transfer belt 2 is decreased. In this case, there is an increase of current flowing to each transfer unit, and this requires the power supply capacity to be increased. However, stable transfer is ensured.

[0177] A high-resistance material can be used for the intermediate transfer belt 2 by providing an electrostatic charge control component to control the electrostatic charge on the surface of the intermediate transfer belt 2. Such an electrostatic charge control component to be used includes a Scorotron charging device or a Corotron charging device where AC or DC power is added. A specified volume of electrical charge on the surface of the intermediate transfer belt 2 is applied to control the electrostatic charge of the belt.

[0178] To allow toner on the photoconductors 1a, 1b, 1c, and 1d to be transferred to the intermediate transfer belt 2, it is necessary to apply the electrical charge with a polarity opposite to that of toner on the side of the intermediate transfer belt 2, or apply the electrical charge with the same polarity as that of the toner to the photoconductors 1a, 1b, 1c, and 1d. Furthermore, to ensure reliable transfer, It is important to ensure a close contact between photoconductors 1a, 1b, 1c, and 1d and intermediate transfer belt 2. In the image forming system according to the present embodiment, roller-formed auxiliary transfer rollers 9a, 9b, 9c and 9d are laid out on the back of the intermediate transfer belt 2, and bias voltage is applied thereto.

[0179] At the same time, the intermediate transfer belt 2 is pressed against the photoconductors 1a, 1b, 1c, and 1d to ensure a close contact. The auxiliary transfer rollers 9a, 9b, 9c and 9d are rollers with metallic shafts covered with sponge. A force is applied to press the intermediate transfer belt 2 against photoconductors 1a, 1b, 1c, and 1d at an appropriate pressure.

[0180] Other than above-mentioned configurations can be used to construct the transfer unit to transfer the toner on the photoconductors 1a, 1b, 1c, and 1d onto the intermediate transfer belt 2.

[0181] When a corona charging device is installed on the back of the intermediate transfer belt 2, electrical charge required for transfer is supplied to the back of the intermediate transfer belt 2, and a blade-formed belt pressing component is used to bring the intermediate transfer belt 2 in close contact with the photoconductors 1a, 1b, 1c, and 1d.

[0182] If arrangement is made to push the auxiliary transfer rollers 9a, 9b, 9c and 9d toward the photoconductors among transfer positions of photoconductors 1a, 1b, 1c, and 1d, electrical charge required for transfer is given to the back of the belt by these auxiliary transfer rollers 9a, 9b, 9c and 9d.

[0183] In the present embodiment, photoconductors 1a, 1b, 1c, and 1d is always in contact with intermediate transfer belt 2. When printing monochrome images, photoconductors for printing unwanted colors are also in contact with the intermediate transfer belt 2. When only some of the photoconductors are required for printing, the unused photoconductors are separated from the intermediate transfer belt and are not used for printing. This method can prolong the service life of photoconductors. To achieve this, a mechanism can be installed to keep the intermediate transfer belt detached from the photoconductors.

[0184] Figures 14 (a) and (b) show an embodiment of the intermediate transfer belt unit cleaner 15 according to the present invention.

[0185] This intermediate transfer belt unit cleaner 15 is designed to clean the toner remaining on the intermediate transfer belt 2. A cleaning blade method is adopted where an elastic blade is used for mechanical raking of toner, similarly to the photoconductor cleaner 6. In the image forming system according to the present embodiment, a cleaning blade is installed on the belt tension roller 10a at the top of the intermediate transfer belt 2, as shown in Figure 1, to remove toner on the intermediate transfer belt 2. Furthermore, a similar cleaning blade is also provided on the belt tension roller 10d located immediately below the cleaning blade provided on the belt tension roller 10a and laid out on the surface of the intermediate transfer belt 2. The belt tension roller 10d installed on the surface of the intermediate transfer belt 2 may be directly in contact with toner. Installation of such a cleaning component is preferred. The belt discharged toner collector 52 to recover discharged toner is laid out beneath the side of the belt tension roller 10d. Toner raked off by the cleaning blade mounted on the belt tension roller 10a drops onto the belt tension roller 10d, and is captured by the cleaning blade to clean the belt tension roller 10d.

[0186] Figure 14A shows another embodiment. In this configuration, the belt tension roller 10d is equipped with a cleaning blade, and a belt discharged toner collector 52 is laid out in the space formed by belt tension roller 10d which keeps the intermediate transfer belt 2 pushed in from the outside. In this configuration, toner raked off by the cleaning blade is shifted to the belt discharged toner collector 52 by gravity. In the image forming system according to the present embodiment, some of the belt tension rollers are installed on the surface of the intermediate transfer belt 2, and are laid out to be pushed inside the belt. This makes it easy to secure a space for the arrangement of the intermediate transfer belt unit cleaner, as described above.

[0187] In addition to the above-mentioned method, a brush roller method can be used, where toner is mechanically and electrically removed by a brush roll supplied with potential. The brush roller method involves a more complicated mechanism than the cleaning blade method, and requires use of a power supply. Since it does not select the direction of cleaning, however, this method is effective in cleaning from above the intermediate transfer belt 2. At the same time, it is characterized by a smaller load of contact with the inter-

mediate transfer belt. This allows smaller torque to be used for driving. In the configuration shown in Figure 14B, the brush cleaner 65 is brought in contact with both the intermediate transfer belt 2 and belt tension roller 10d, to provide simultaneous cleaning of the intermediate transfer belt 2 and the belt tension roller 10d in contact with photoconductor surface. Toner cleaned by brush cleaner 65 is fed to the recovering roller 66, and is raked off by the recovering blade 67. The raked toner falls down into the belt discharged toner collector 52 where it is collected. In addition, a brush roller 65 is laid out in contact with both the intermediate transfer belt 2 and belt tension roller 10b, as in the case of Figure 14B, and the belt tension roller 10b is equipped with a cleaning blade. The cleaned toner is shifted to the belt tension roller 10d Such a method can be applied in the image forming system according to the present embodiment.

[0188] Uneven electrostatic charge may occur to toner on the intermediate transfer belt 2 due to contact with photoconductors 1a, 1b, 1c, and 1d. Uneven change will take the form of differences in transfer efficiency, and will cause uneven images. In the image forming system according to the present embodiment, a toner charging device 11 is provided to keep uniform the electrostatic charge of toner on the intermediate transfer belt 2. The toner charging device 11 is equipped with a shield case to enclose a wire. It is a Scorotron charging device with a grid provided between the wire and intermediate transfer belt 2. Electrostatic charge potential on the surface of the intermediate transfer belt 2 is controlled by the grid potential.

[0189] To make an effective use of the toner charging device 12 in this case, a conductive component set to a specified potential is installed on the back of the intermediate transfer belt opposite to the toner charging device 12.

[0190] In the present embodiment, a transfer device 13 is installed to transfer the toner image on the intermediate transfer belt 2 to the recording medium.

[0191] Toner images on the intermediate transfer belt 2 are color images, so there are different thicknesses of the toner in each part of one image. To ensure complete transfer of these images onto the paper, a close contact between toner and paper is essential. The present embodiment uses a roller-formed transfer device 13 to keep the recording medium in close contact with toner. At the same time, bias voltage is applied to ensure toner transfer. To ensure a close contact of the recording medium with toner, the transfer device 13 uses a roller having the surface of the metallic shaft covered with elastic layer made of solid or sponge-like rubber material. Voltage required to transfer toner from the intermediate transfer belt 2 to the recording medium is applied to the metallic shaft. To make an effective use of the static electricity to transfer toner, the elastic layer is made of semiconductive or conductive material. To press the recording medium against intermediate transfer belt 2 firmly, the transfer device 13 is configured to be pressed against the intermediate transfer belt 2 by adequate gravity.

[0192] When the intermediate transfer belt 2 and transfer device 13 are kept in contact with each other as in the present embodiment, fogging toner or the like on the intermediate transfer belt 2 may deposit on transfer device 13 when paper is not passed. Toner deposited on the transfer device 13 will deposit on the back of the recording medium, causing contamination. To avoid this, a mechanism can be installed to keep the transfer device 13 away from the intermediate transfer belt 2. When paper is passed, the transfer device 13 is kept away from the intermediate transfer belt 2 except when the transfer device 13 must be brought in contact with the intermediate transfer belt 2. This minimizes the contamination of the transfer device 13. Contamination of the transfer device 13 due to toner can be removed positively by installing a mechanism to clean the transfer device 13, or a mechanism which gives adequate bias voltage having the same polarity as that of toner to the transfer device 13, and transfers toner deposited on the transfer device 13 back to the intermediate transfer unit.

[0193] Another configuration of the transfer device in the image forming system according to the present embodiment is provided by the corona transfer device which can also be used if the paper and toner can be brought in contact with each other using the blade-formed paper pressing component.

[0194] In the color image forming system according to the present embodiment, an electric charge eliminator for paper 14 (Figure 1) is installed on the downstream side in the paper feed direction of the transfer device 13.

[0195] The recording medium after toner transfer retains part of the electrical charge supplied at the time of transfer, so is adsorbed onto the intermediate transfer belt by static electricity. In the present embodiment, a small-diameter belt tension roller 10c is installed at the position opposite to the transfer device 13, the recording medium can be separated by the curvature radius of the belt tension roller 10c and paper rigidity. However, stable separation may not be achieved for thin paper with less rigidity or highly resistant OHP sheet where the transfer electrical charge is likely to remain. In order to facilitate separation of the recording medium, the image forming system according to the present embodiment has an electric charge eliminator for paper 14 installed to eliminate the remaining electric charge. The electric charge eliminator for paper 14 according to the present embodiment consists of needle-formed minute electrodes with a specified potential are arranged along the transfer device 13. Electric discharge is caused by the potential on the back of the recording medium and minute electrode, thereby eliminating electrical charge on the back of the recording medium and minute electrode.

[0196] When more reliable elimination of electric

charge is required to meet the higher printing speed requirements, an AC electric charge elimination method using the AC corona discharge can also be used as an alternate device for electric charge eliminator for paper 14.

[0197] When stable paper feed is also required after transfer, the belt transfer device having both functions of toner transfer and paper separation/feed, instead of the above-mentioned transfer device 13 and electric charge eliminator for paper 14, can also be used in the image forming system in conformity to according to this method.

[0198] A method of roughening the surface of the intermediate transfer belt 2 can also be used to improve the separation of the recording medium. If the surface of the intermediate transfer belt 2 is roughened, space is created between the recording medium and paper, and adsorption is reduced. This ensures easy separation of paper. On the other hand, if the intermediate transfer belt 2 is roughened, an image defect such as white dropout is likely to occur. However, when deterioration of picture quality can be prevented by improving the electrostatic charge of toner, this method is effectively used.

[0199] The following describes an embodiment of fusing device 19 used in the image forming system according to the present invention.

[0200] In the image forming system according to the present invention, the fusing device is required to provide performances to ensure good color development of color image and high printing speed.

[0201] This requires the fusing device to supply the heat required to dissolve toner at proper timing. In the compact image forming system as in the present invention, heat generated by the fusing device is likely to affect other processes. Fusing is preferred to be made at the lowest possible temperature

[0202] The present embodiment uses the fusing belt to fuse the toner. Toner fusing section and heating time can be prolonged by arrangement of the fusing belt in a long line along the paper feed path or in much the same direction as multiple photoconductors 1a, 1b, 1c, and 1d are laid out. This makes it possible to sufficiently heat the recording medium where toner is deposited, and ensures fusing of toner. Since a thin component called a fusing belt is used to perform heat conduction using, quick response is ensured without the need of supplying excessive heat. This makes it possible to fuse toner at a comparatively low temperature.

[0203] Furthermore, as shown in Figure 1, photoconductor 1a, intermediate transfer belt 2 and fusing device 19 are laid out in the horizontal direction, and the intermediate transfer belt 2 is stretched in the longitudinal direction by the length of arranged photoconductors 1. The fusing device long in the direction of a paper feed path can be laid out without increasing the size of the system. So there is no problem with use of the fusing device by the belt-formed component as described above.

[0204] Figure 15 shows the detailed configuration of this fusing device 19.

[0205] The fusing device 19 of the present embodiment comprises a belt-formed fusing belt 74, a fusing belt tension rollers 75a and 75b to give tension to it, a heater 76, a close contact roller 77 to bring paper i close contact with the fusing belt, a separation roller 78 to separate paper, and a tension roller 79 to give tension to the fusing belt.

[0206] The belt-formed fusing belt 74 can use a heat resistant resin, heat resistant rubber, metallic belt or a combination thereof. The present embodiment uses the belt which is producing by coating the nickel belt made of highly heat conductive metal with the silicone rubber with excellent mold releasing property having a thickness of 20 to 40 microns. This belt-formed fusing belt 74 is stretched by three rollers. Fusing belt tension rollers 75a and 75b are metallic rollers, and the close contact roller 77 and separation roller 78 are installed at respective opposite positions. The roller roller 79 is designed to give tension to the fusing belt, and is fixed by a spring. Heater 76 such as nichrome wire heater is installed inside the fusing belt tension rollers 75a. A close contact roller 77 is a metallic roller with elastic layer on the surface. It is laid out to be pressed against fusing belt tension roller 75a, and brings the recording medium in contact with the fusing belt 74 to transmit the heat of fusing belt 74 to toner. The separation roller 78 installed opposite to the belt tension roller 75b separates the recording medium. At the same time, it gives shearing force to molten toner and prevents the toner from sticking to the fusing belt 74.

[0207] Both the separation roller 78 and close contact roller 77 use metallic roller having an elastic layer on the surface.

[0208] To ensure that heat generated by the fusing device 19 does not affect inside the main unit, the fusing device 19 in the present embodiment has a heat insulating component 80 installed inside.

[0209] In the fusing device shown in Figure 15, the distance between the close contact roller 77 and separation roller 78 is 40 to 100 mm when considered from the view point of layout configuration of other process parts. So when the process speed is 100 mm/s, the time of 0.4 to 1 sec. to heat toner on the recording medium can be secured. Since the roller fusing device using two rollers to provide fusing can secure a nip width of only several millimeters at most, toner can be heated sufficiently when heating time of 0.02 to 0.06 sec. is taken into account.

[0210] When easy fusing is possible by use of the toner of a low melting point or when fusing performance can be ensured using the method of reducing the fusing rate in conformity to the type of the recording medium, it is possible to use the fusing device based on roller fusing method where toner is fused by passing the recording medium between two rollers heated to a specified

temperature.

[0211] Figure 16 shows the configuration of the roller fusing device as another embodiment of the fusing device according to the present invention.

[0212] This configuration uses a pair of rollers having internal heating sources -- heat roller 81 and backup roller 82 -- to fuse toner on the recording medium by heat and pressure. The heat roller 81 and backup roller 82 have their surfaces coated with an elastic body such as silicone rubber and fluorine rubber. Roller surfaces may be provided with a surface layer of fluorine resin to improve separation from toner. Furthermore, an oil coating mechanism 83 to paint silicone oil on the surface of the heat roller 81 is provided, thereby improving separation of toner and surface of heat roller 81.

[0213] Furthermore, a trace quantity of toner and paper powder may adhere to the fusing component at the time of fusing. Such toner and paper may accumulated on the surface, reducing the service life of the roller. To remove a very small quantity of toner and paper, cleaning mechanisms 84 to clean the surface of the roll components are provided on the heat roller 81 and backup roller 82.

[0214] It goes without saying that oil coating mechanism and cleaning mechanism is applicable to the embodiment shown in Figure 15.

[0215] Paper heating component 85 to heat paper can be installed on the upstream side of the fusing device 19 in the paper feed direction as shown in Figure 17. An infrared ray heater and plate-formed heater is used as a paper heating component 85. It heats the recording medium in a contact or non-contact mode. Installation of the paper heating component 85 enables the paper to be preheated, thereby ensuring easy fusing.

[0216] The following describes an embodiment of the form cassette and the peripheral unit according to the present invention. The form cassette 16 according to the present embodiment is intended to store paper. It is laid out on the bottom of the main unit, and accommodates several hundreds of paper. To actuate the form cassette 16 correctly, it is necessary to install a device which presses the recording medium against the paper feed mechanism from downward. In the present embodiment, the form cassette 16 has a built-in spring. It uses a mechanism which pushes the recording medium upward when the form cassette 16 is mounted inside the main unit. To set a great number of recording media into the form cassette 16, it is possible to install a mechanism to more the recording media long in the longitudinal direction by the power of the main unit.

[0217] When the form cassette 16 is added, the additional cassette 103 are stacked below the main unit as shown in Figure 21. They can be installed without changing the ground contact area. The additional cassette 103 can accommodates paper of various sizes and types. Such paper can be handed by the above-mentioned embodiments.

[0218] The following specifically describes the feeding of paper as a recording medium.

[0219] The paper feed mechanism 17 to feed the recording medium from the form cassette 16 comprises at least pick roller 86 and separation pad 87. The pick roller 86 has its surface provided with a component such as rubber and other materials with a high friction coefficient with the recording medium. It is laid out in contact with the recording medium, and pulls the recording medium out of the cassette by rotation.

[0220] The separation pad 87 is made of a frictional component such as rubber and cork, and is laid out in contact with the surface of the pick roller 86. It separates into each sheet the recording media pulled out by the pick roller 86.

[0221] The pick roller 86 must be kept in contact with both the tip of the recording medium and separation pad 87. This makes it difficult to reduce the diameter of the pick roller 86, and this makes it necessary to provide a space to install a pick roller 86 between the form cassette 16 and the imaging process of the main unit. If this space has to be reduced for the construction of the system, the following paper feed mechanism can be used.

[0222] The following describes the embodiment of the paper feed mechanism according to the present invention.

[0223] The recording medium is first divided into the portion to be picked up and the portion to be separated. A pick roller 86, separation pad 87 and retard roller are. installed for each. To describe it in details, the recording medium in the cassette is pulled out of the form cassette 16 by the pick roller 86. In this case, two or more sheets of the recording media may be picked up. To separate two or more recording media in this case, a feed roller and retard roller are installed respectively upward and downward through the recording medium. The feed roller laid out upward rotates in the same direction as the pick roller 86, while the retard roller laid out downward is made to rotate in the reverse direction by the torque limiter. When two or more sheets of recording media is sent, the lower retard roller rotates in the reverse direction to push excessive recording medium back to the form cassette 16. If there is only one sheet of recording medium or all excessive ones have been pushed into the cassette side, the torque limiter is actuated by the friction between the recording medium and the upper feed roller to feed the paper to the resist roller 18.

[0224] In this method, pick roller 86, feed roller and retard rollers are arranged in a line. This allows the space of the paper feed mechanism 17 to be reduced since rollers with smaller diameters can be used.

[0225] The following describes another embodiment of paper feed mechanism 17:

[0226] A separation pad 87 is laid out horizontal with the form cassette 16, and the component to pull the recording medium from the form cassette 16 is formed

into the pick belt. The pick belt used has its surface covered with rubber having a high friction coefficient, or has the surface of the hard rubber belt material covered with rubber with a high friction coefficient to give strength. Paper feed method is as described above. Since a smaller diameter roller can be used as a pick belt tension roller to stretch the pick belt, the space for the paper feed mechanism 17 can be reduced.

[0227] The resist roller 18 according to the present embodiment is provided to adjust the tips of paper and to feed the paper to the transfer unit in conformity to the timing of toner images on the intermediate transfer belt 2. It uses a combination of two rollers; a metallic roller to increase the rotational speed accuracy and a elastic roller with the metallic shaft covered with rubber and others to get a sufficient force to feed the recording medium. The resist roller 18 is also equipped with a paper sensor. When paper has reached the resist roller 18, the pick roller 86 is stopped, the resist roller 18 is driven in conformity to the timing of the image tip on the intermediate transfer belt 2, thereby adjusting the position of the image and paper.

[0228] With reference to Figure 18, the following describes the bias voltage applied to each of process parts in the image forming system according to the present embodiment.

[0229] To develop and transfer toner, bias voltage must be applied to development devices 5a, 5b, 5c and 5d and transfer device 13. Direction of bias during development and transfer is determined by toner polarity, development method, and settings on the zero potential section.

[0230] Figure 18 shows an example of bias voltage application to illustrates potential applied to various sections.

[0231] The present embodiment uses the organic photoconductor and negative electrostatic toner as photosensitive materials of photoconductors, and adopts the reversed development method which allows development at higher resolution.

[0232] Since the charging devices 3a, 3b, 3c and 3d changes the photoconductors 1a, 1b, 1c, and 1d in negative potential, negative bias is applied to the development devices 5a, 5b, 5c and 5d. In this case, a. c. voltage may be superimposed as bias applied to the charging devices 3a, 3b, 3c and 3d in order to stabilize the photoconductor potential, since the charging device is a charging roller. Toner is transferred from the photoconductors 1a, 1b, 1c, and 1d to the intermediate transfer belt 2 by making the photoconductor side negative or by making the side of the intermediate transfer belt 2 positive. In the present embodiment, components of different bias voltages such as charging devices 3a, 3b, 3c and 3d, and development devices 5a, 5b, 5c and 5d are laid out are arranged around the photoconductors 1a, 1b, 1c, and 1d. So reference potential, namely, zero potential is given to photoconductors 1a, 1b, 1c, and 1d, and positive potential is given to the side of the intermediate transfer belt 2; namely, positive voltage is given to the auxiliary transfer rollers 9a, 9b, 9c and 9d. When toner is transferred from the intermediate transfer belt 2 to the paper, a positive potential greater than that applied to intermediate transfer belt 2 is given to the transfer device 13.

[0233] Negative bias having the same polarity as that of the toner is applied to the belt tension roller 10d pushed inside the intermediate transfer belt 2 in order to ensure resistance to adhesion of toner on the intermediate transfer belt 2. Toner left untransferred on the transfer device 13 may have its polarity reversed, so positive bias can be applied to this belt tension roller 10d.

[0234] Except for the above-mentioned bias configuration, the following configuration is also possible: Belt tension roller 10a, 10b, 10c and 10d to stretch the intermediate transfer belt 2, and auxiliary transfer rollers 9a, 9b, 9c and 9d are set to zero potential; and negative bias is applied to each of the photoconductors 1a, 1b, 1c, and 1d, thereby transferring toner to the intermediate transfer belt 2.

[0235] Bias voltage applied to these processes can be adjusted by the user to stabilize and improve image quality. For example, if the exposure level of the exposure device 4a,4b,4c,4d and bias voltage for development can be adjusted by the control panel and switch in response to characteristics of the photoconductors 1a, 1b, 1c, and 1d, then image quality can be adjusted by simple operations.

[0236] Control of bias of each section based on the extension of the above-mentioned method is also effective to stabilize image quality. For example, when the toner image on the intermediate transfer belt is to be transferred onto the recording medium, bias voltage may be different depending on the type of the recording medium, for example, between a high-resistance OHP and paper with its moisture absorbed. Installation of a transfer voltage control mechanism shown in Figure 19 will ensure transfer stability in response to changes in the type of the recording medium and environmental conditions.

[0237] The transfer voltage control mechanism shown in Figure 19 comprises a transfer device current detector 93 to detect the current flowing to the transfer device 13, a transfer voltage controller 94 to determine the bias voltage of the transfer device 13 based on the result of the transfer device current detector 93, and a high voltage power supply 95 which applies bias voltage to the transfer device where the output value is variable. It provides a stable transfer in response to the type of the recording medium and changes in environmental conditions at all times by detecting the current flowing to the transfer device 13 and by changing the transfer bias voltage in response to this current. Furthermore, It detects the volume of deposited toner, and changes the exposure volume, and bias voltage for development and transfer based on this finding. It also uses the tempera-

ture and humidity sensors to detect the environmental conditions in which the system is placed, thereby controlling the bias of each process.

[0238] With reference to Figures 22 to 25, the following describes the configuration equipped with duplex printing function as another embodiment of the image forming system according to the present invention.

[0239] For duplex printing, the paper must be folded. The following configuration applies to the image forming system according to the present embodiment

[0240] Figure 22 shows an embodiment where the paper with printed surface is folded by the paper ejector. This duplex printing mechanism has a paper ejector equipped with a feed roller 104 capable of forward/backward rotation and a guide component 105 to guide paper to duplex paper feed path 106. Furthermore, a duplex paper feed path 106 is provided on the left outside surfaced of the main unit. The paper guide rollers 107 to feed paper on the duplex paper feed path 106 are laid out at intervals smaller than the length of the longest paper to be printed. The outlet of the duplex paper feed path 106 is provided below the resist roller 18 of the main unit. Paper fed through the duplex paper feed path 106 is again fed to the transfer position by the resist roller 18. In this configuration, paper with printed surface has its tip caught by the feed roller, and is fed to the eject tray of the main unit. The feed roller is reversed when the end of paper has passed through the guide component 105. At the same time, the position of the guide component 105 is changed to feed the end of paper to the duplex paper feed path 106. Then paper is fed through the duplex paper feed path 106 to the position just before the resist roller 18. Images to be printed on the back of this paper are formed on the intermediate transfer belt 2, and paper is fed into the transfer unit by the resist roller 18 in conformity to timing for transfer. This methods allows the duplex paper feed path 106 to be manufactured in a comparatively compact form. Furthermore, the duplex paper feed mechanism itself does not require a complicated connection with the main unit. This allows users to adjust settings by themselves.

[0241] Figure 23 shows the method of folding paper with printed surface on the left of the system, outside the transfer device 13 and fusing device 19. In this duplex printing mechanism, a guide component 105 to guide to the duplex paper feed path 106 is installed on the paper ejector, and an S-formed duplex paper feed path 106 which can fold the paper is installed on the outer left of the main unit. The outlet of the duplex paper feed path 106 is provided below the resist roller 18 of the main unit. Paper fed through the duplex paper feed path 106 is again fed to the transfer position by the resist roller 18. According to this configuration, paper with printed surface is fed to duplex paper feed path 106 by the guide component 105. The paper is fed through the duplex paper feed path 106 to the position A, and the paper guide roller 107 is rotated in the reverse direction.

[0242] Then the paper is fed to the position just before the resist roller 18. When images to be printed on the back of this paper are formed on the intermediate transfer belt 2, and are transferred, paper is fed to the transfer unit by the resist roller 18, and images are formed on the back. The paper guide located before resist is provided to prevent the paper fed to position A and fed back from being fed back through the duplex paper feed path 106. The duplex paper feed mechanism itself does not require a complicated connection with the main unit. This allows users to adjust settings by themselves. Furthermore, duplex printing is possible with paper getting out of the main unit. This method ensures high quality images to be recorded without paper contaminated in the process from paper feed to paper ejection.

[0243] Figure 24 how to fold back paper with printed surface below the system. The ejector of this duplex mechanism has a guide component 105 to guide paper to paper ejector. The duplex paper feed path 106 is laid out on the outer left of the main unit, and the duplex paper storage tray 108 is arranged below the main unit. The outlet of the duplex paper feed path 106 is provided on the duplex paper storage tray 108 below the main unit. Paper fed through the duplex paper feed path 106 is fed to the duplex paper storage tray 108, where paper is fed in the reverse direction to the resist roller 18. In this configuration, paper with printed surface is guided to the duplex paper feed path 106 by the guide component 105, and is stored in the duplex paper storage tray 108 through the duplex paper feed path 106. Then the paper guide roller 107 is rotated in the reverse direction to send paper just before the resist roller 18. When images to be printed on the back of this paper are formed on the intermediate transfer belt 2, and are transferred, paper is fed to the transfer unit by the resist roller 18, and images are formed on the back. The paper guide located at the inlet of the duplex tray is provided to prevent the paper coming from the duplex tray from being fed to the duplex paper feed path 106. In this method, a duplex paper storage tray 108 is laid out horizontally and can accommodate a great deal of paper for duplex printing. It is suited for printing on a great deal of paper. The duplex paper feed path 106 is simple in structure without allowing jamming to occur often, and ensures excellent maintainability.

[0244] A long duplex paper feed path is required. So while paper is fed, it may shift or incline from the specified position.

[0245] To make compensation for them, it is possible to provide a regulation component to regulate the paper end or a mechanism to correct paper position by positive operation of the regulation component.

[0246] To provide a compact configuration, high speed, high picture quality and excellent maintainability as described above, the image forming system according to the present embodiment has a intermediate transfer belt 2 stretched in the longitudinal direction at

the center of the main unit. The same number of photoconductors 1 as that of the required toner colors are arranged in the longitudinal direction on one of these long stretched surfaces. Transfer device 13 and fusing device 19 are arranged on the other surface. A form cassette 16 is laid out below the main unit, and the transfer device 13 and fusing device 19 are arranged from below in that order, thereby feeding, transferring and fusing the recording media. Multiple photoconductors 1a, 1b, 1c, and 1d are installed in the photoconductor unit 22, and the exposure device 4a, 4b, 4c and 4d is secured to the enclosure 2000 of the main unit so that photoconductor unit 22 can be removed in the direction where photoconductors 1a, 1b, 1c, and 1d are arranged, and the development devices 5a, 5b, 5c and 5d can be removed in the direction where photoconductors 1a, 1b, 1c, and 1d are arranged.

[0247] This allows the image forming system according to the present embodiment to provide both high quality image recording and high speed. It also permits the system to provide a compact configuration, reasonable price and excellent user maintainability.

[0248] The following describes the another embodiment of the image forming system according to the present invention.

[0249] An embodiment of the image forming system including the exposure unit in the photoconductor unit 22 shown in Figure 1 will be described first with reference to Figure 25.

[0250] In the image forming system shown in Figure 25, photoconductors 1a, 1b, 1c, and 1d of different colors are arranged in the longitudinal direction, and intermediate transfer belt 2 is arranged on one of the surfaces where photoconductors are laid out. This is the same as the image forming system shown in Figure 1. The difference is as follows: In the image forming system shown in Figure 1, development devices 5a, 5b, 5c and 5d, and exposure devices 4a, 4b, 4c and 4d are stacked on the surface opposite to the intermediate transfer belt of the surface where photoconductors are arranged. By contrast, in the image forming system shown in Figure 25, exposure devices 4a, 4b, 4c and 4d of different colors are laid out inside the photoconductor unit 2 where photoconductors 1a, 1b, 1c, and 1d of different colors are laid out. In this case, to minimize the size of the photoconductor unit 22, use of a small exposure device is preferred. The embodiment in Figure 24 uses a LED exposure device, as discussed above. In the present embodiment, exposure devices 4a, 4b, 4c and 4d corresponding to different colors and photoconductors 1a, 1b, 1c, and 1d are integrated into one unit. The space and parallelism of photoconductors of different colors and exposure device, and their positional relationship are laid out accurately, and can be maintain under stable conditions. This allows registration of the images of different colors to be performed more accurately. In the embodiment shown in Figure 1, the capacity of the development devices 5a, 5b, 5c and 5d can be increased the amount corresponding to the space accommodating the exposure devices 4a, 4b, 4c and 4d. This ensures a longer service life of the development device.

[0251] The peripheral length of the photoconductor cannot be smaller than the size (including length) of the recording medium, and there is a design limit to the length between photoconductors. So the size cannot be reduced in the longitudinal direction literally by the amount corresponding to the space accommodating the exposure devices 4a, 4b, 4c and 4d, but the system can be made compact by minimizing the size.

[0252] The following further describes still another embodiment of the image forming system according to the present invention.

[0253] In the embodiment shown in Figure 1, charging device 3, exposure device 4, development device 5, intermediate transfer belt 2, photoconductor cleaner 6 and erase lamp 8 are laid out around the photoconductors 1. From the layout sequence and rotational direction of photoconductors, these process part must be laid out below the line connecting between the development point of photoconductors and transfer point. To ensure higher speed and high definition of printing, these process parts must be greater in size and more complicated in structure. To increase the space below the photoconductors in the embodiment shown in Figure 26, the photoconductor unit 22 with photoconductors 1a, 1b, 1c, and 1d laid out at a fixed position is arranged obliquely on the side of development devices 5a, 5b, 5c and 5d. This photoconductor unit 22 can be replaced when it is pulled out upward in a slanting direction where photoconductors are laid out. Upward shift of the contact point between the photoconductor and intermediate transfer belt 2 gives allowance to the structure of the process laid out below the photoconductors. At the same time, layout allowance can be increased.

[0254] The following describes the intermediate transfer belt 2 as an embodiment of the image forming system according to the present invention. This will be described with regard to the configuration stretched in a long time in the lateral direction.

[0255] In the embodiment shown in Figure 27, photoconductors of different colors are arranged in the lateral direction. This is different from the arrangement of the embodiment shown in Figure 1 where photoconductors are arranged in the longitudinal direction. System configuration is made compact by placing the photoconductors on one side of the intermediate transfer unit and the fusing device on the opposite side.

[0256] The intermediate transfer belt 2 stretched in a long line in the direction of gravity is provided at the center of the main unit. Photoconductors 1a, 1b, 1c, and 1d in the same number as that of four tone colors used are installed on the upper side of the intermediate transfer belt 2 in the lateral direction, namely, in the direction where the intermediate transfer belt is stretched. Imaging units 109a, 109b, 109c and 109d to provide electro-

static charge, development and cleaning and exposure device 4a, 4b, 4c and 4d are installed, around each photoconductor. Furthermore, transfer device 13 and intermediate transfer belt unit cleaner 15 are laid out around the intermediate transfer belt 2, and a paper feed path to allow paper to pass by is provided below the intermediate transfer belt 2. A form cassette 16, pick roller 86, resist roller 18, transfer device 13, fusing device 19 and paper eject path are installed on the paper feed path along the paper feed path.

[0257] The present embodiment shown in Figure 27 has the photoconductors laid out on one side of the intermediate transfer unit, and the fusing device installed on the opposite side. This provides a smaller size than the one where the intermediate transfer unit and fusing device are laid out in parallel. Furthermore, to ensure stable feed of the recording media, the form cassette 16 is placed below the main unit, and the transfer device 13 and fusing device 19 are laid out in that order from downward, thereby feeding recording media upward, transferring and fusing.

[0258] In the embodiment shown in Figure 28, the intermediate transfer belt 2 stretched in a long line in the direction of gravity is provided at the center of the main unit. Photoconductors 1a, 1b, 1c, and 1d in the same number as that of four tone colors used and fusing device 19 are installed in the lateral direction above the intermediate transfer belt 2. Imaging units 109a, 109b, 109c and 109d to provide electrostatic charge, development and cleaning, and exposure devices 4a, 4b, 4c and 4d are laid out on and around the photoconductors. The fusing device 19 is placed above the belt tension roller 10e located on the surface where photoconductors are laid out on the most upstream side of the intermediate transfer belt 2. The transfer device 13 and intermediate transfer belt unit cleaner 15 are located around the intermediate transfer belt 2. The transfer device 13 is installed opposite to the belt tension roller 10e located on the surface where photoconductors are laid out on the most upstream side of the intermediate transfer belt 2. The intermediate transfer belt unit cleaner 15 is laid out on the top surface of the intermediate transfer belt 2. The image forming system according to the present embodiment has a paper feed path which allows paper to be fed from below the intermediate transfer belt 2 to the upper left without bending paper very much. The paper feed path as a form cassette 16, pick roller 86, resist roller 18, transfer device 13, fusing device 19 and paper eject path installed along the feed path.

[0259] The form path as a paper feed path is formed in a large circular arc, and is located close to the outer surface of the system. So This allows various recording media such as cardboard, letter and postal card to be fed from the form cassette 16 without being jammed. It also facilitates removal of paper after jamming.

[0260] The present invention provides an image forming system characterized by compact configuration, high speed and high quality recording. It also provides an image forming system featuring an excellent maintainability.

Claims

1. An image forming system comprising;

    (1) multiple photoconductors (1a-d),
    (2) multiple exposure devices (4a-d) to form static latent images on each of said photoconductors,
    (3) multiple development devices (5a-d) to form toner images on each of said photoconductors,
    (4) an intermediate transfer device (2, 9a-d) to form a color toner image by superimposing said toner images,
    (5) a transfer device (13) to transfer said color toner image to a recording medium, and
    (6) a fusing device (19) to fuse said color toner image on said recording medium;
    wherein said multiple photoconductors form one integral unit (22).

2. An image forming system according to Claim 1 wherein at least one end of each of said multiple photoconductors of said integral unit is connected by one support (110a, b).

3. An image forming system according to Claim 1 wherein said multiple photoconductors are arranged in one column and can be mounted or dismounted in the direction of arrangement.

4. An image forming system according to Claim 3 wherein said multiple photoconductors can be pulled out upward.

5. An image forming system according to Claim 3 wherein said multiple photoconductors can be pulled out in an upward slanting direction.

6. An image forming system according to Claim 1 wherein said fusing device can be pulled out upward.

7. An image forming system according to Claim 1 wherein said exposure device has a LED light source (27).

8. An image forming system comprising;

    (1) multiple photoconductors (1a-d) arranged in a longitudinal line,
    (2) multiple development devices (5a-d) and multiple exposure devices (4a-d) arranged on one side of said multiple photoconductors,

(3) an intermediate transfer device (2, 9a-d) arranged on the other side of said multiple photoconductors, and

(4) a form cassette (16) arranged below said multiple photoconductors;

wherein said multiple development devices and multiple exposure devices are arranged in the vertical direction to said multiple photoconductors, and said multiple development devices and multiple exposure devices are arranged alternately with respect to the direction of said multiple photoconductors.

9. An image forming system according to Claim 8 comprising an enclosure (200) wherein multiple exposure devices are arranged fixed to said enclosure.

10. An image forming system according to Claim 8 wherein multiple development devices and multiple exposure devices are arranged alternately in the order of exposure devices and development devices from the side of said form cassette.

11. An image forming system according to Claim 8 wherein said intermediate transfer device (2) is designed in belt form, at least four rollers (10a-d) are provided to stretch said belt, and at least one of said rollers (10d) is arranged in contact with the outer surface of said belt.

12. An image forming system according to Claim 11 wherein said roller arranged in contact with the outer surface of said belt is equipped with a cleaner (15) to clean said belt.

13. An image forming system according to Claim 8 wherein a belted fusing device (19) is arranged on one side of said intermediate transfer device in almost the same direction as that of said multiple photoconductors.

14. An image forming system according to Claim 13 wherein said belted fusing device has an insulating material on the side where said intermediate transfer device is installed.

15. An image forming system according to Claim 8 wherein a transfer unit (13) and a fusing device (19) are arranged on one side of said intermediate transfer device.

16. An image forming system according to Claim 15 wherein a paper heating component to heat recording media is provided between said transfer unit and said fusing device.

17. A photoconductor unit comprising;

(1) multiple photoconductors (1a-d) arranged in a line

(2) multiple charging devices (7a-d) to charge each of said photoconductors uniformly, and

(3) multiple photoconductor cleaners to clean each of said multiple photoconductors;

wherein said multiple photoconductors, multiple charging devices and multiple photoconductors cleaners are configured in one unit.

18. A photoconductor unit according to Claim 17 comprising multiple exposure devices (4a-d) to expose the surface of each of said photoconductors.

19. A photoconductor unit according to Claim 18 wherein said multiple exposure devices have a LED light source (27).

20. An image forming system comprising;

(1) multiple photoconductors (1a-d) supported by one or two supports (110a, b),

(2) a holder to hold said support (1),

(3) multiple exposure devices (4a-d) to form static latent images on each of said photoconductors,

(4) multiple development devices (5a-d) to form toner images on each of said photoconductors,

(5) an intermediate transfer device (2, 9a-d) to form a color toner image by superimposing said toner images,

(6) a transfer device (13) to transfer said color toner image to a recording medium, and

(7) a fusing device (19) to fuse said color toner image on said recording medium wherein said multiple photoconductors form one integral unit (22).

21. An image forming system according to Claim 19 comprising an enclosure (200) wherein multiple photoconductors including said support form one integral unit which can be mounted or dismounted15as desired, and said holder is arranged in said enclosure.

FIG. 1

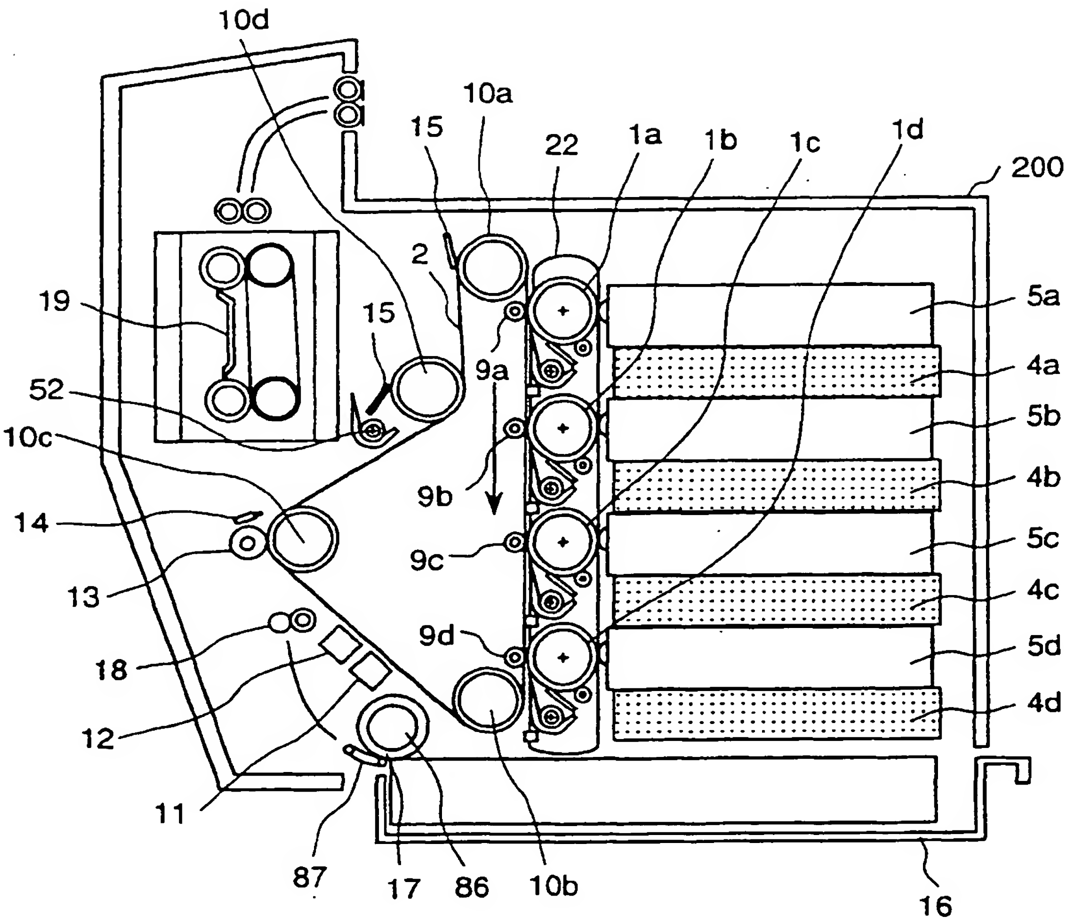

10d
10a
15
22
1a
1b
1c
1d
200
2
19
15
5a
4a
52
9a
5b
10c
9b
4b
14
5c
9c
13
4c
9d
18
5d
4d
12
11
87
17
86
10b
16

FIG. 2

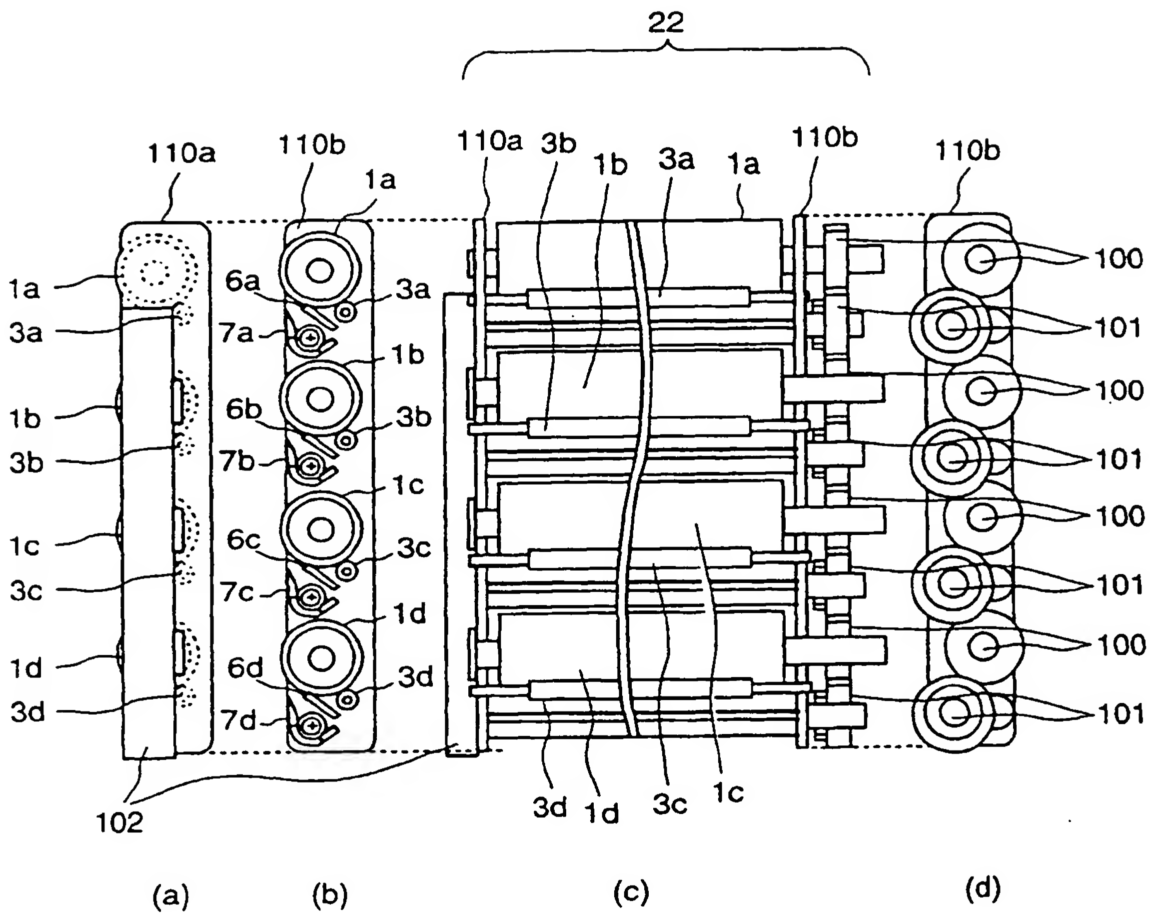

22
110a
110b
1a
110a
3b
1b
3a
1a
110b
110b
1a
3a
1b
3b
1c
3c
1d
3d
6a
7a
3a
1b
6b
3b
7b
1c
6c
3c
7c
1d
6d
3d
7d
100
101
100
101
100
101
100
101
102
3d
1d
3c
1c
(a)
(b)
(c)
(d)

FIG. 3

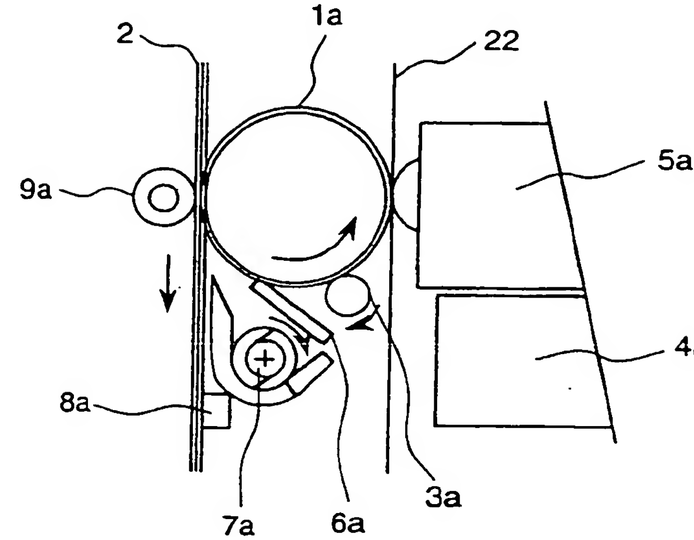


FIG. 5

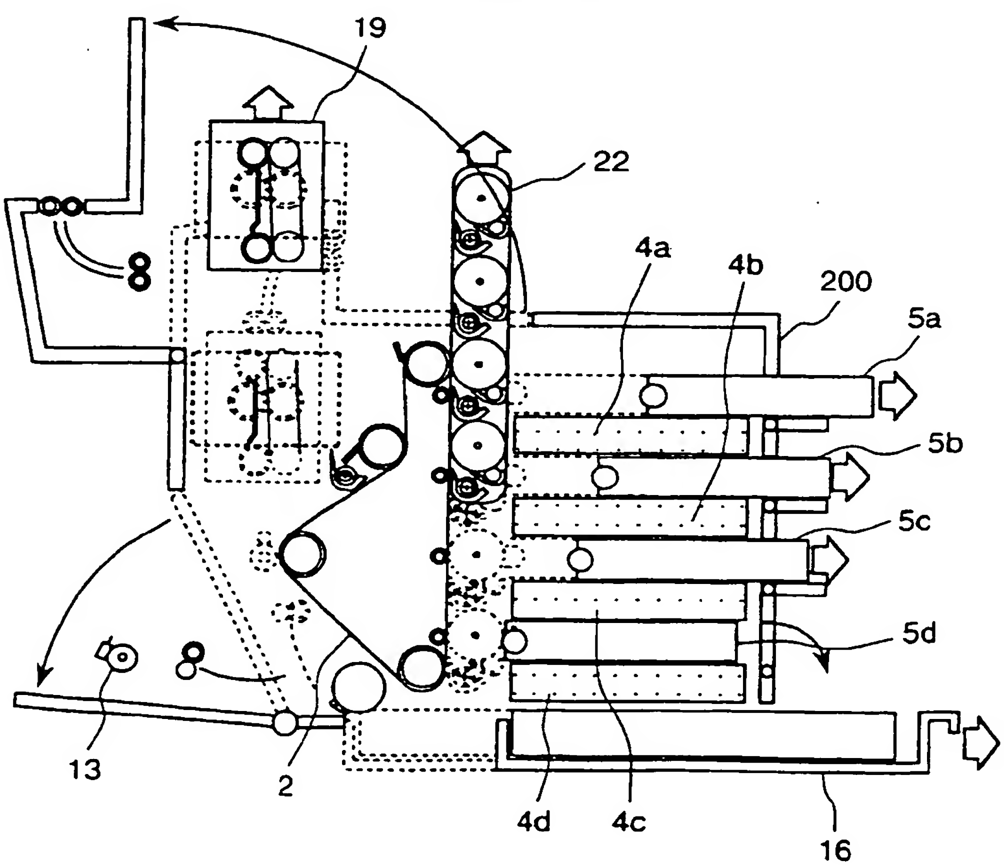


FIG. 4

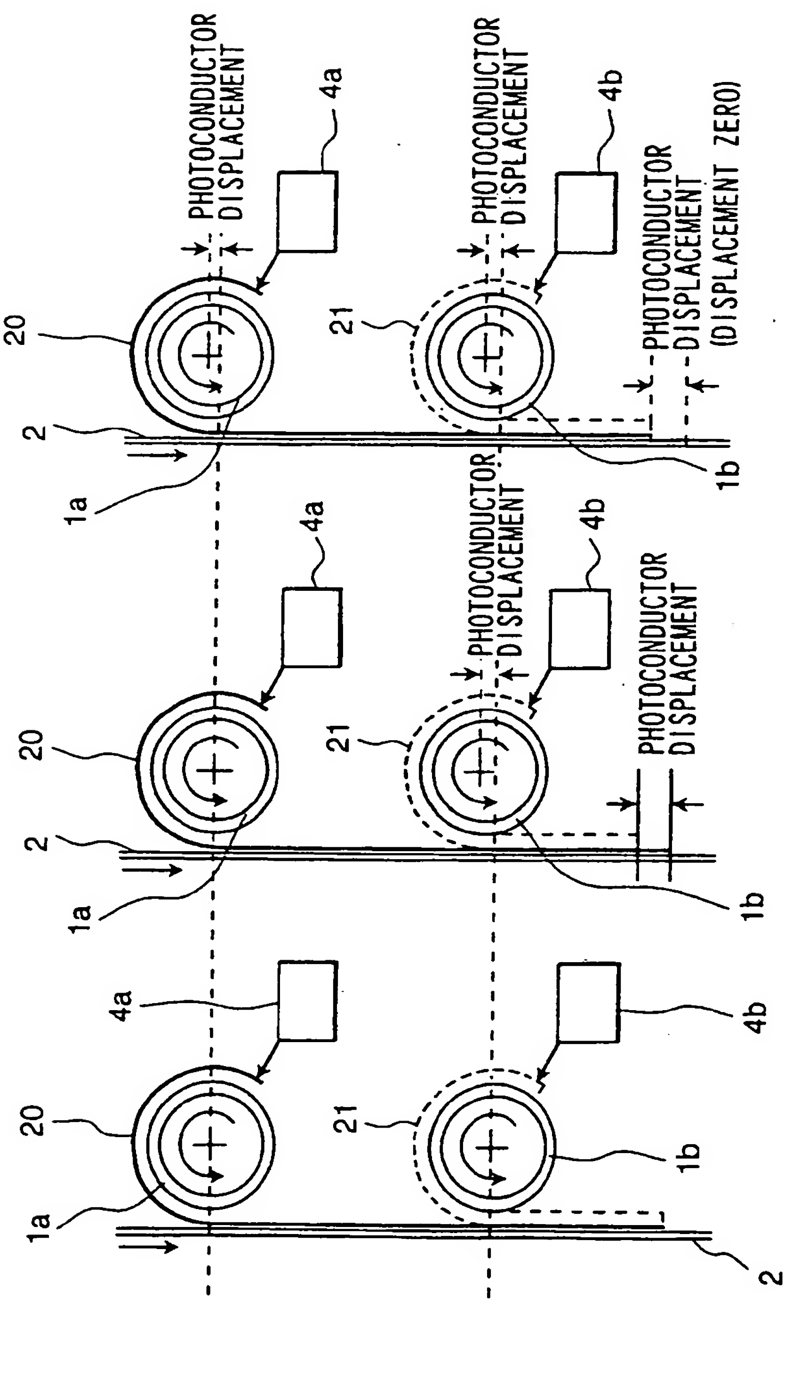

PHOTOCONDUCTOR DISPLACEMENT
4a
20
2
1a
PHOTOCONDUCTOR DISPLACEMENT
4b
21
PHOTOCONDUCTOR DISPLACEMENT (DISPLACEMENT ZERO)
1b
4a
20
2
1a
PHOTOCONDUCTOR DISPLACEMENT
4b
21
PHOTOCONDUCTOR DISPLACEMENT
1b
4a
20
1a
21
4b
1b
2

FIG. 6

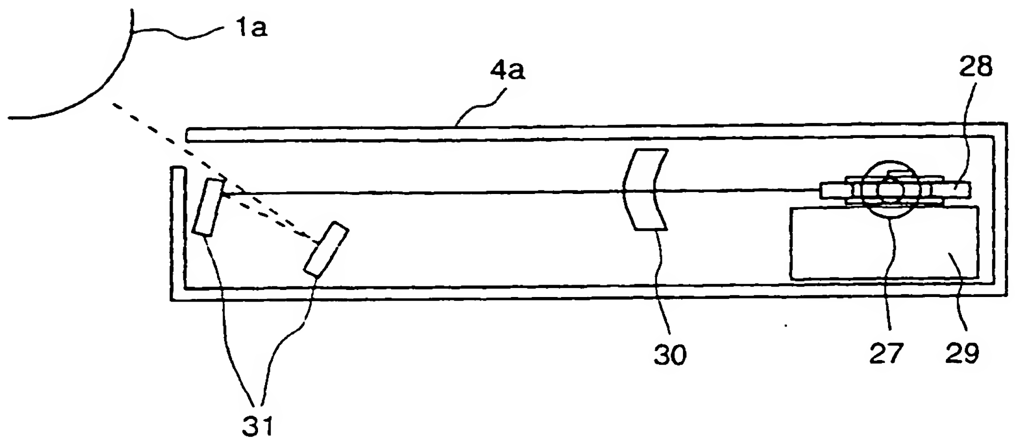


FIG. 8

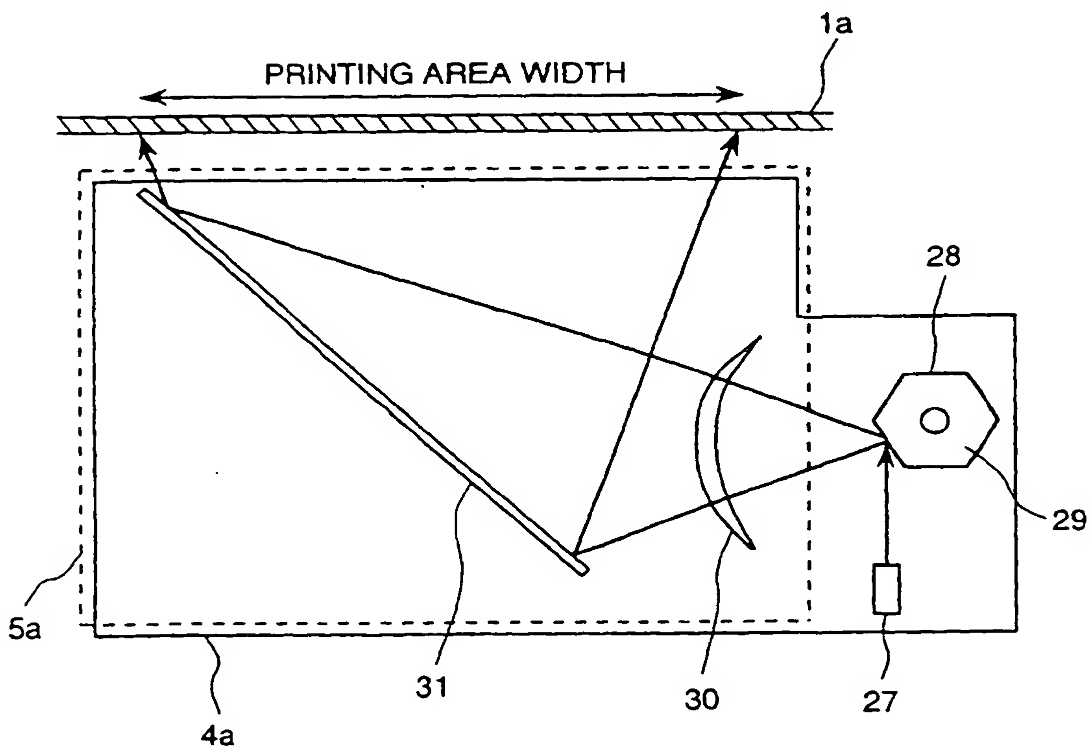


FIG. 7

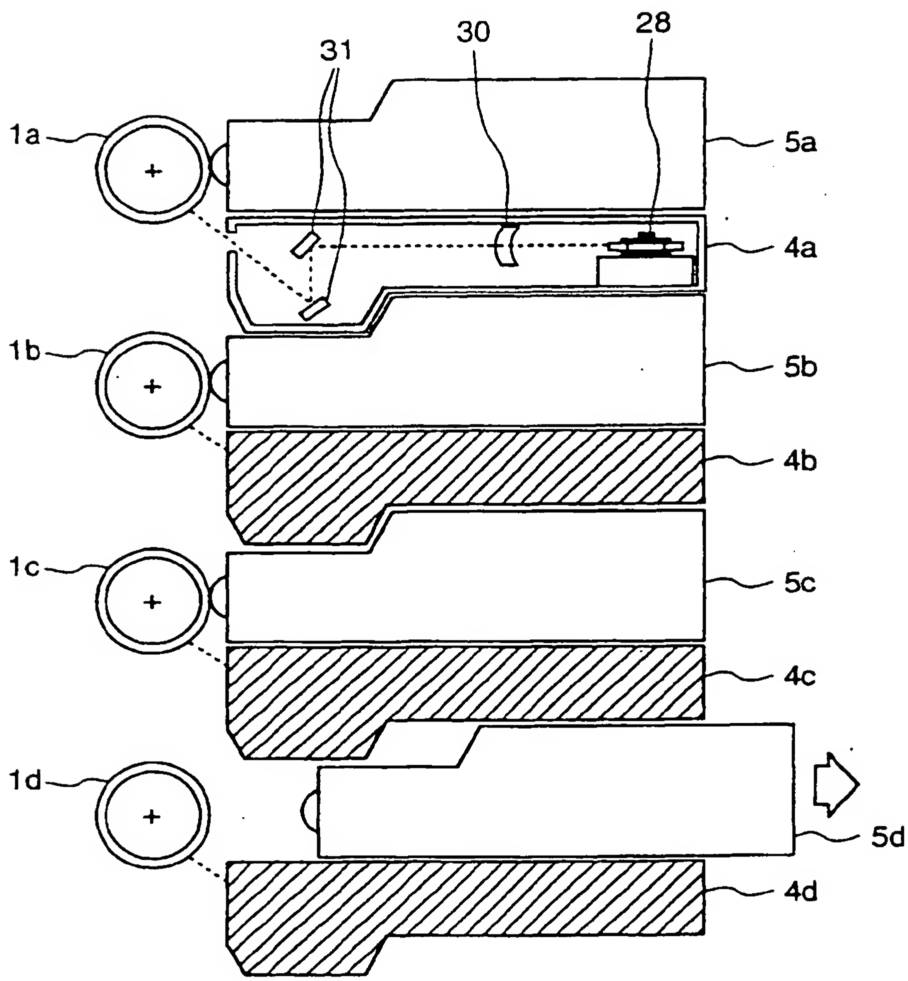


FIG. 9

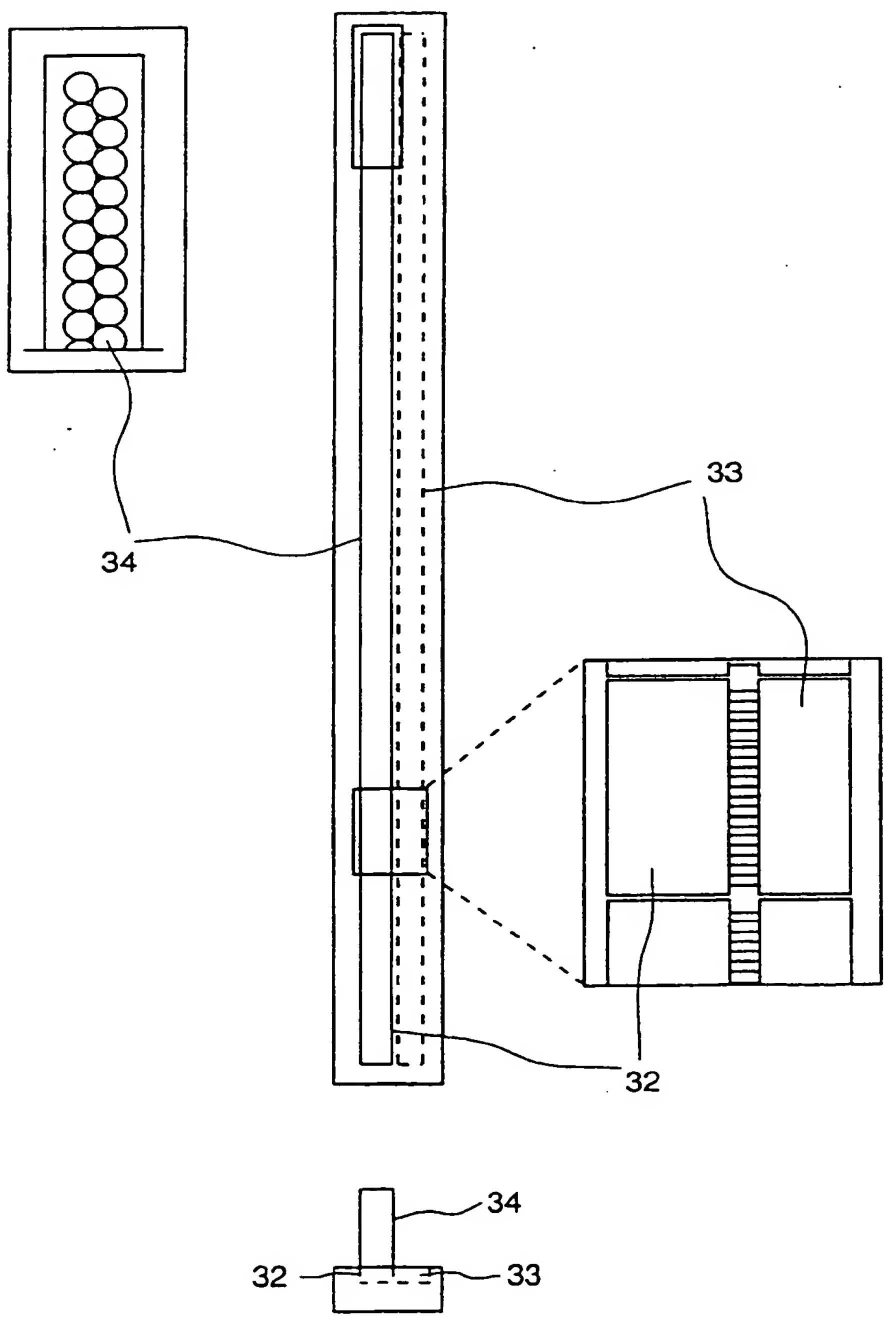


FIG. 10

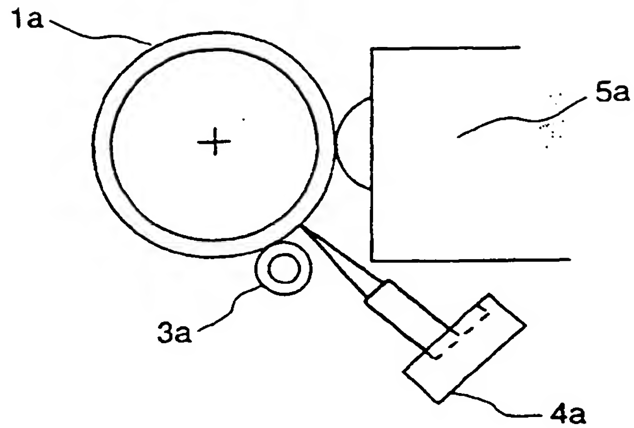


FIG. 11

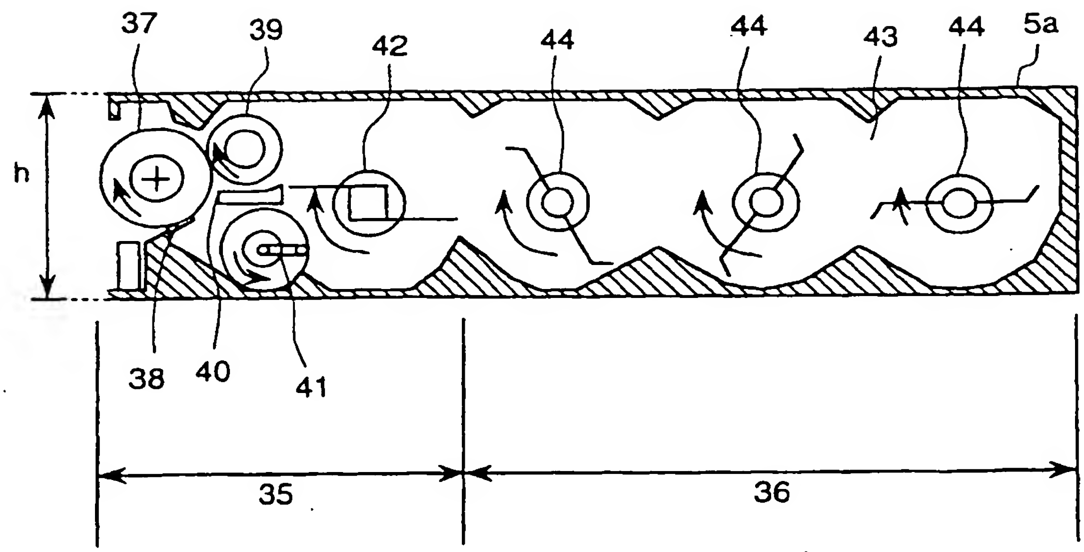


FIG. 12

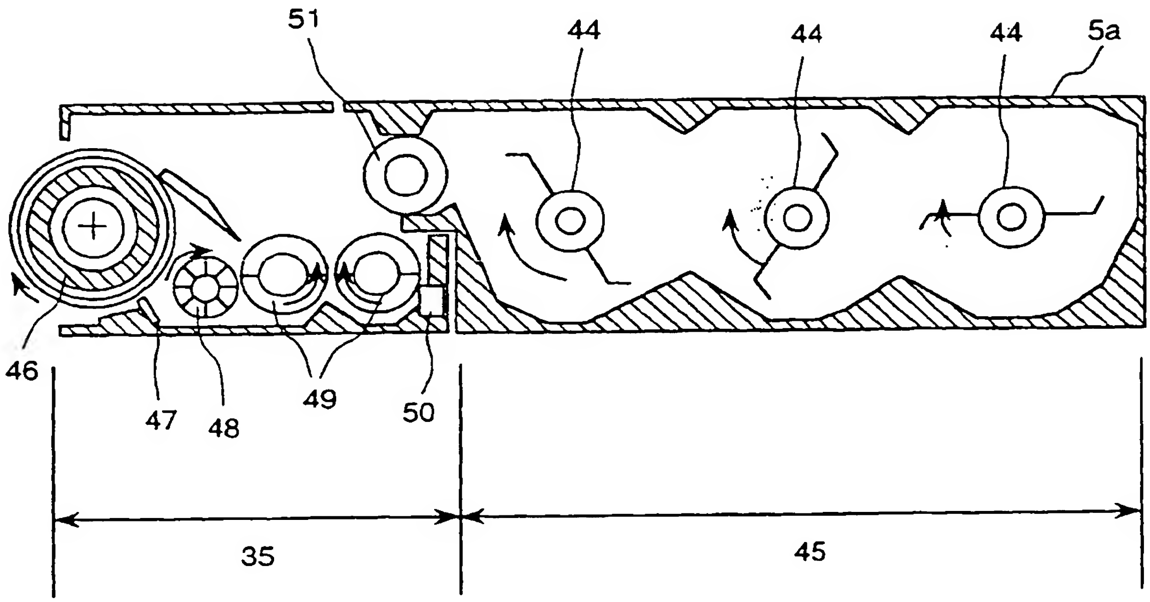


FIG. 15

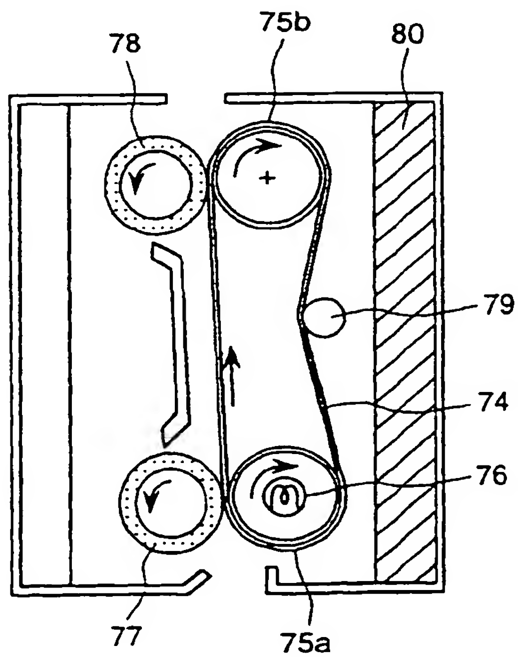


FIG. 13A

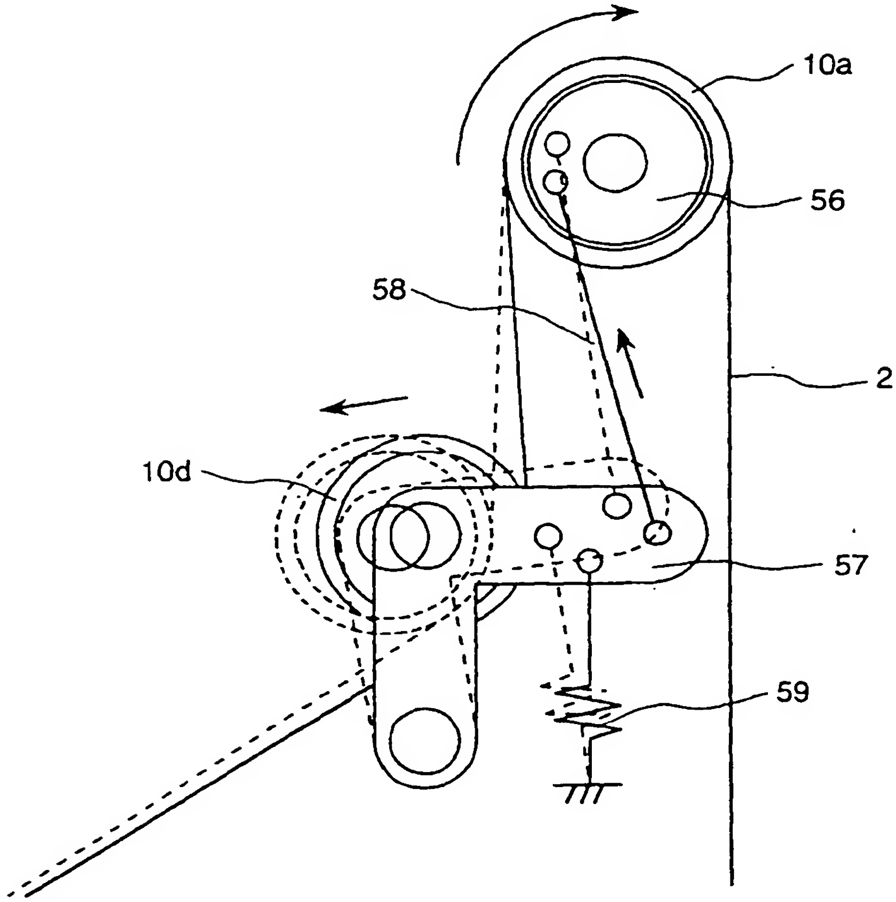


FIG. 13B

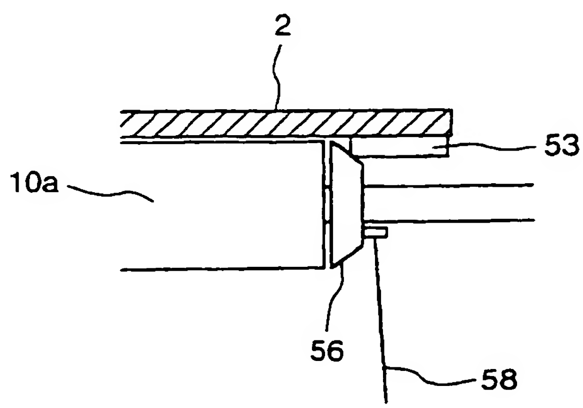


FIG. 14A

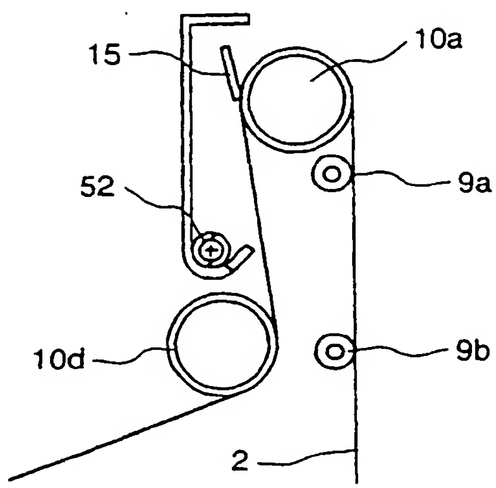


FIG. 14B

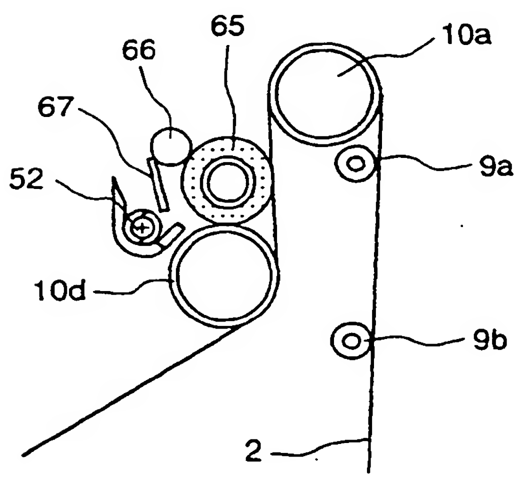


FIG. 16

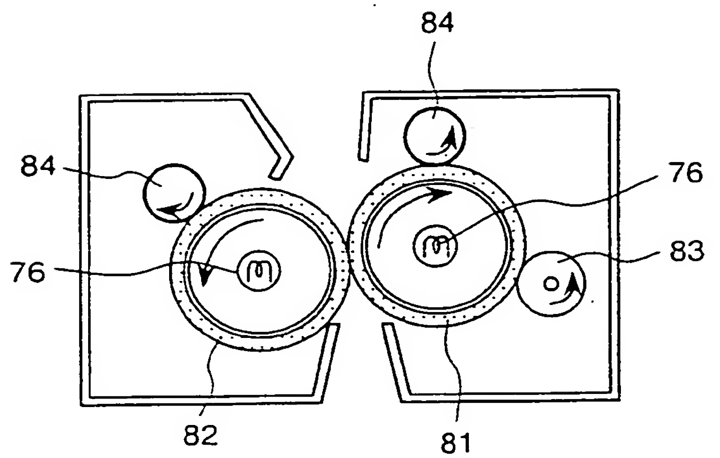


FIG. 17

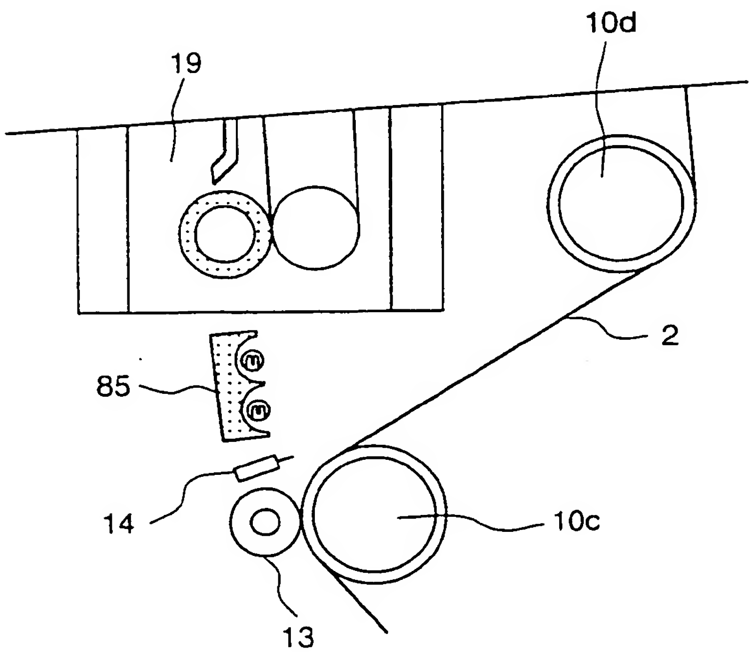


FIG. 18

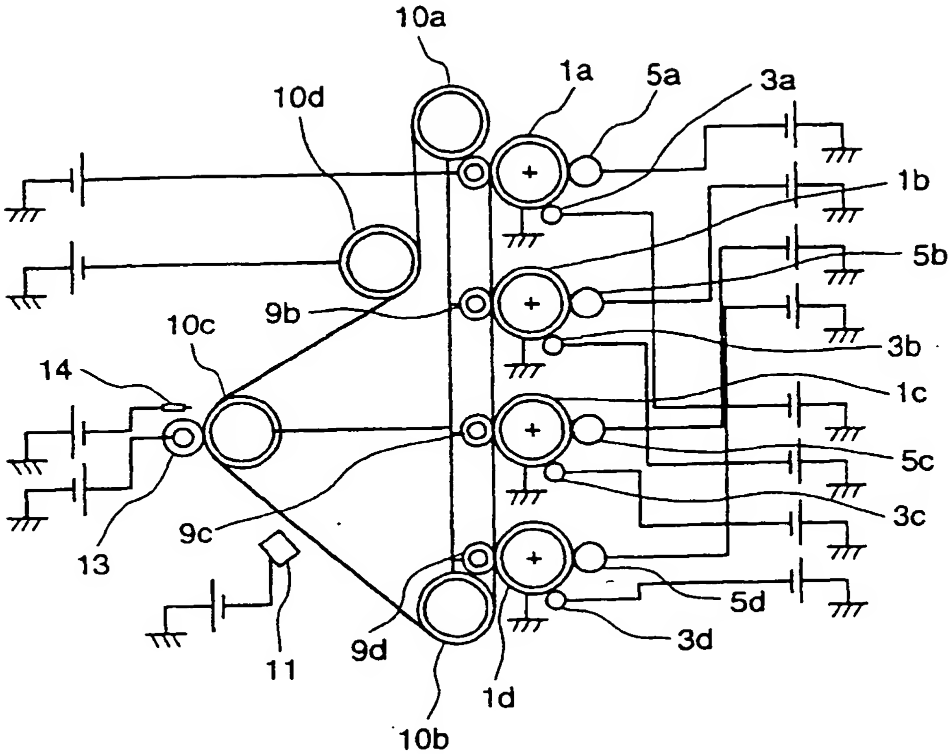

10a
1a
5a
3a
10d
1b
5b
9b
10c
3b
14
1c
5c
13
9c
3c
5d
11
9d
3d
1d
10b

FIG. 19

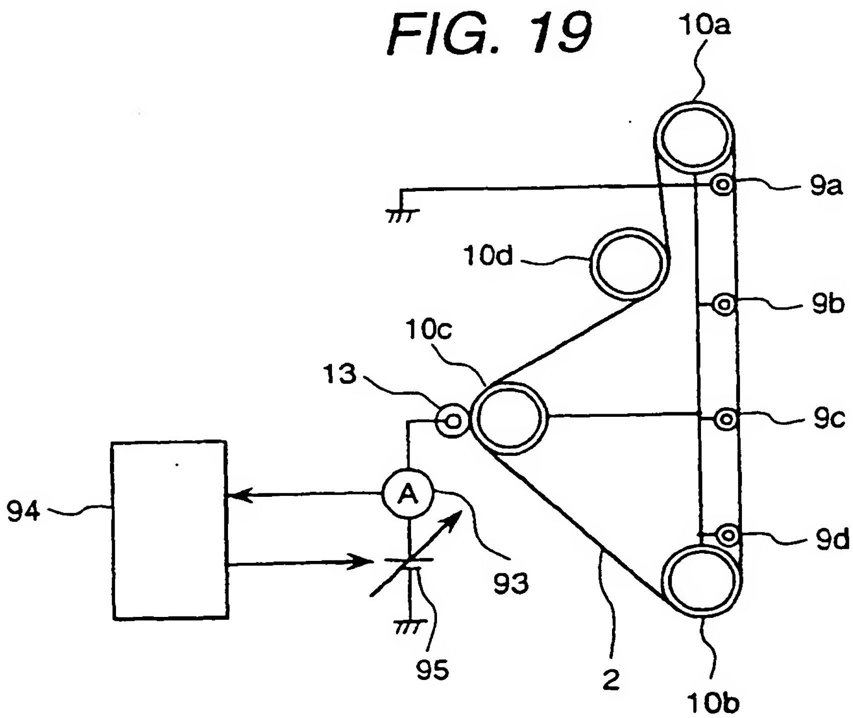

10a
9a
10d
9b
10c
13
9c
94
A
9d
93
95
2
10b

FIG. 20

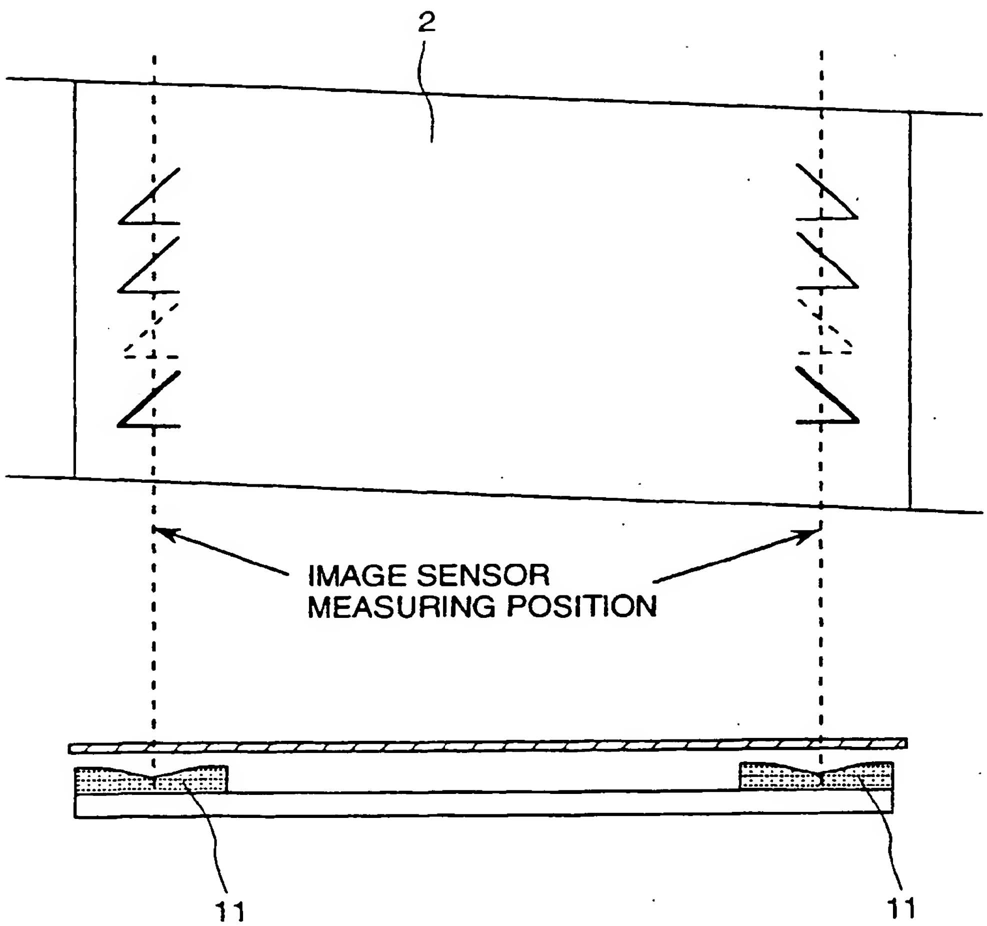


FIG. 21

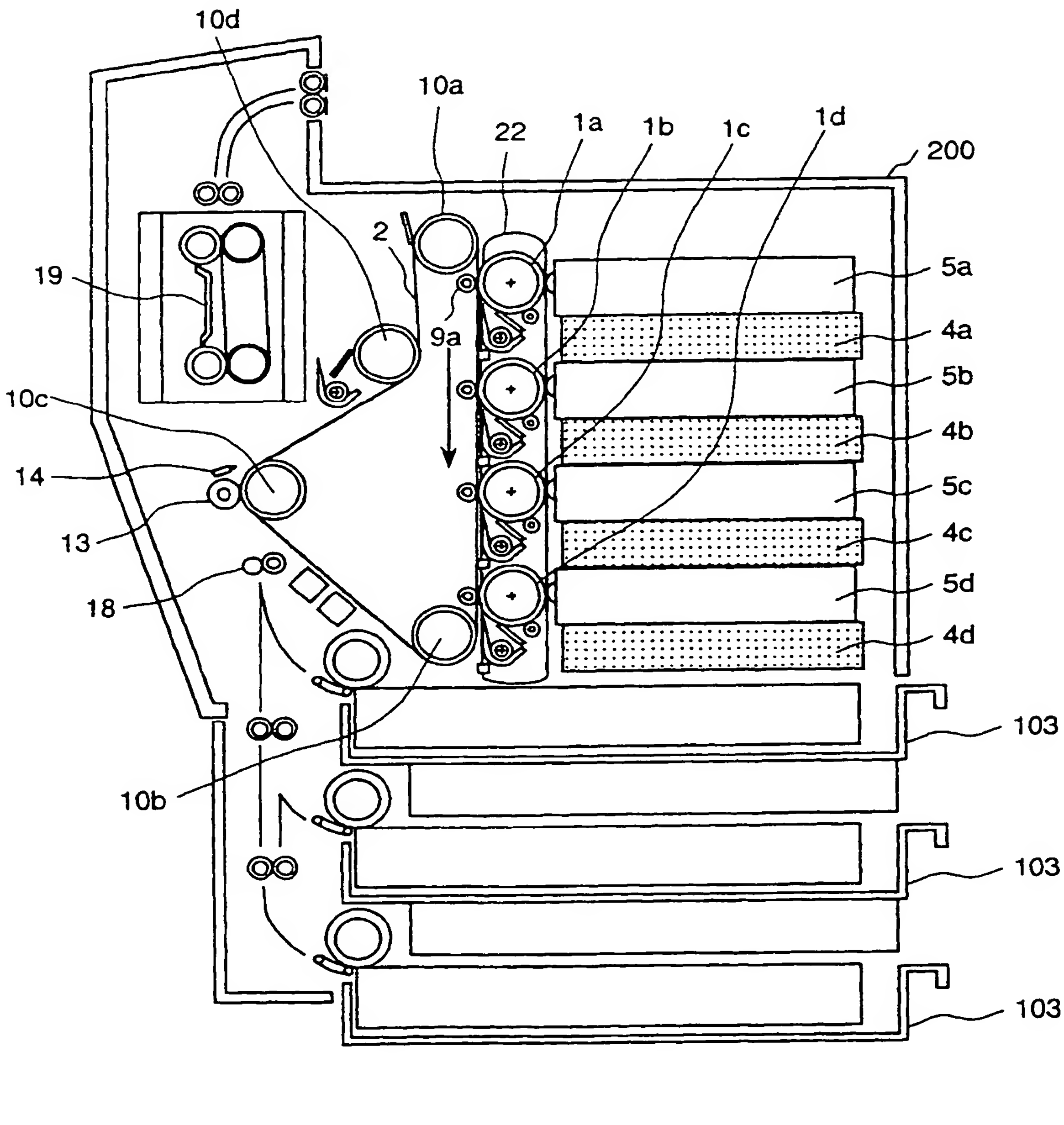

10d
10a
22
1a
1b
1c
1d
200
2
19
5a
4a
9a
5b
10c
4b
14
5c
13
4c
18
5d
4d
103
10b
103
103

FIG. 22

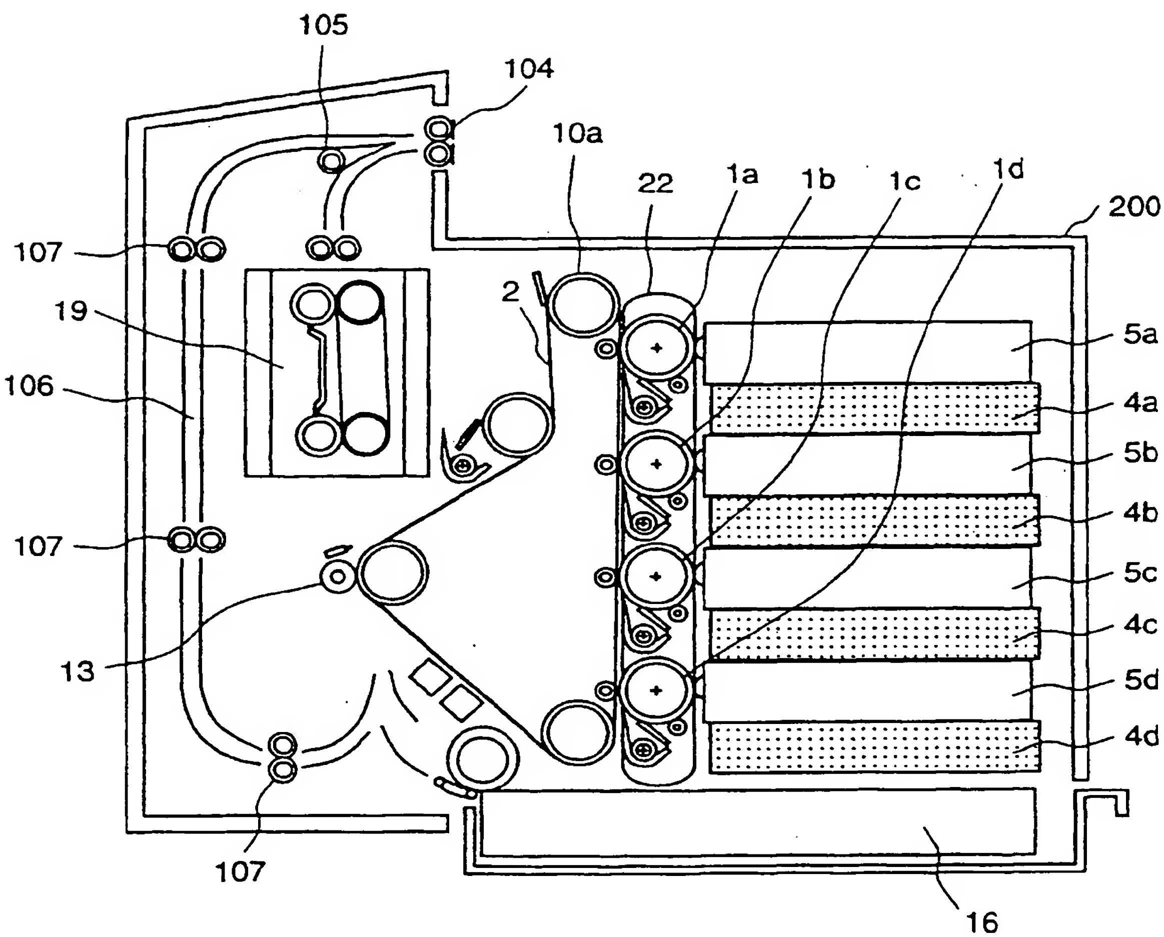

105
104
10a
22
1a
1b
1c
1d
200
107
19
2
5a
106
4a
5b
107
4b
5c
13
4c
5d
4d
107
16

FIG. 23

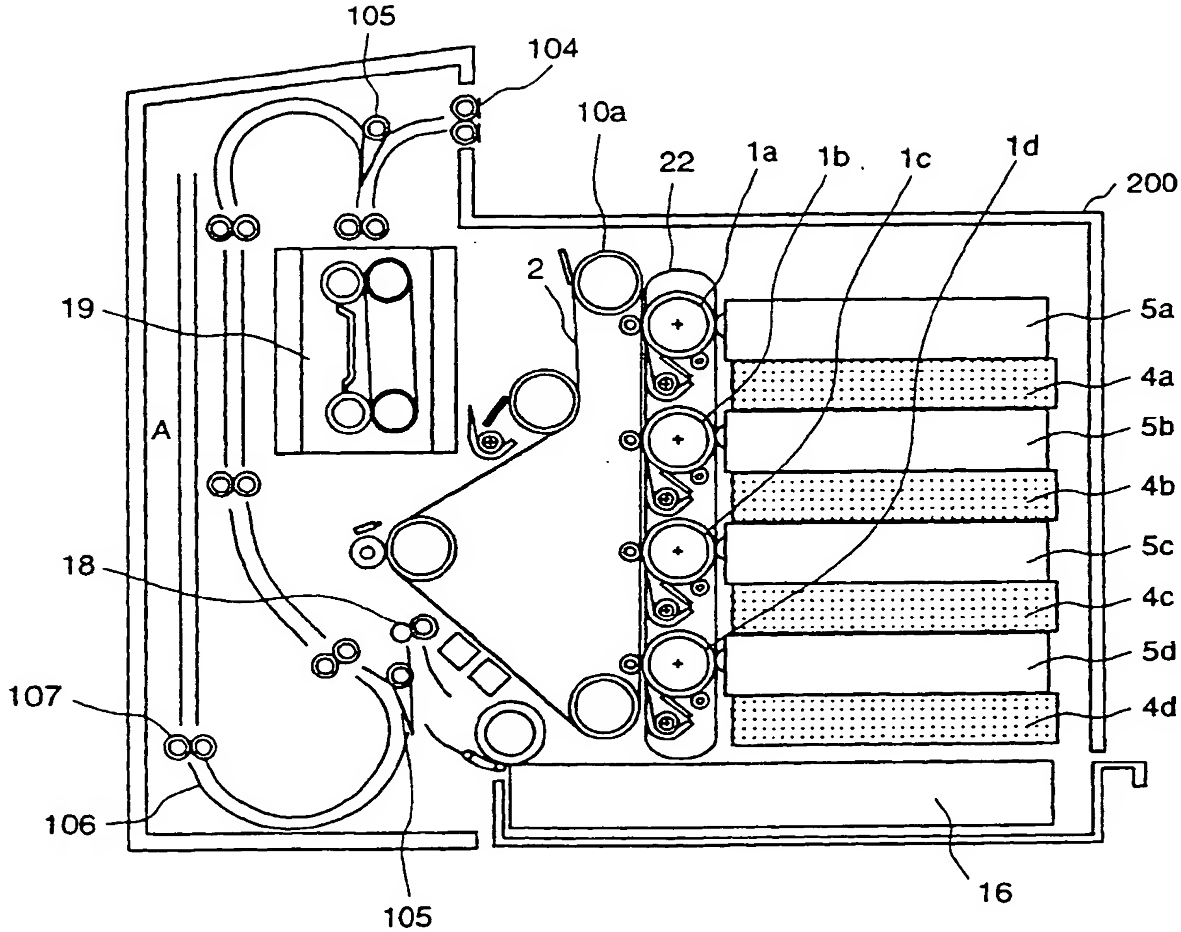

105
104
10a
22
1a
1b
1c
1d
200
2
19
5a
4a
A
5b
4b
5c
18
4c
5d
107
4d
106
16
105

FIG. 24

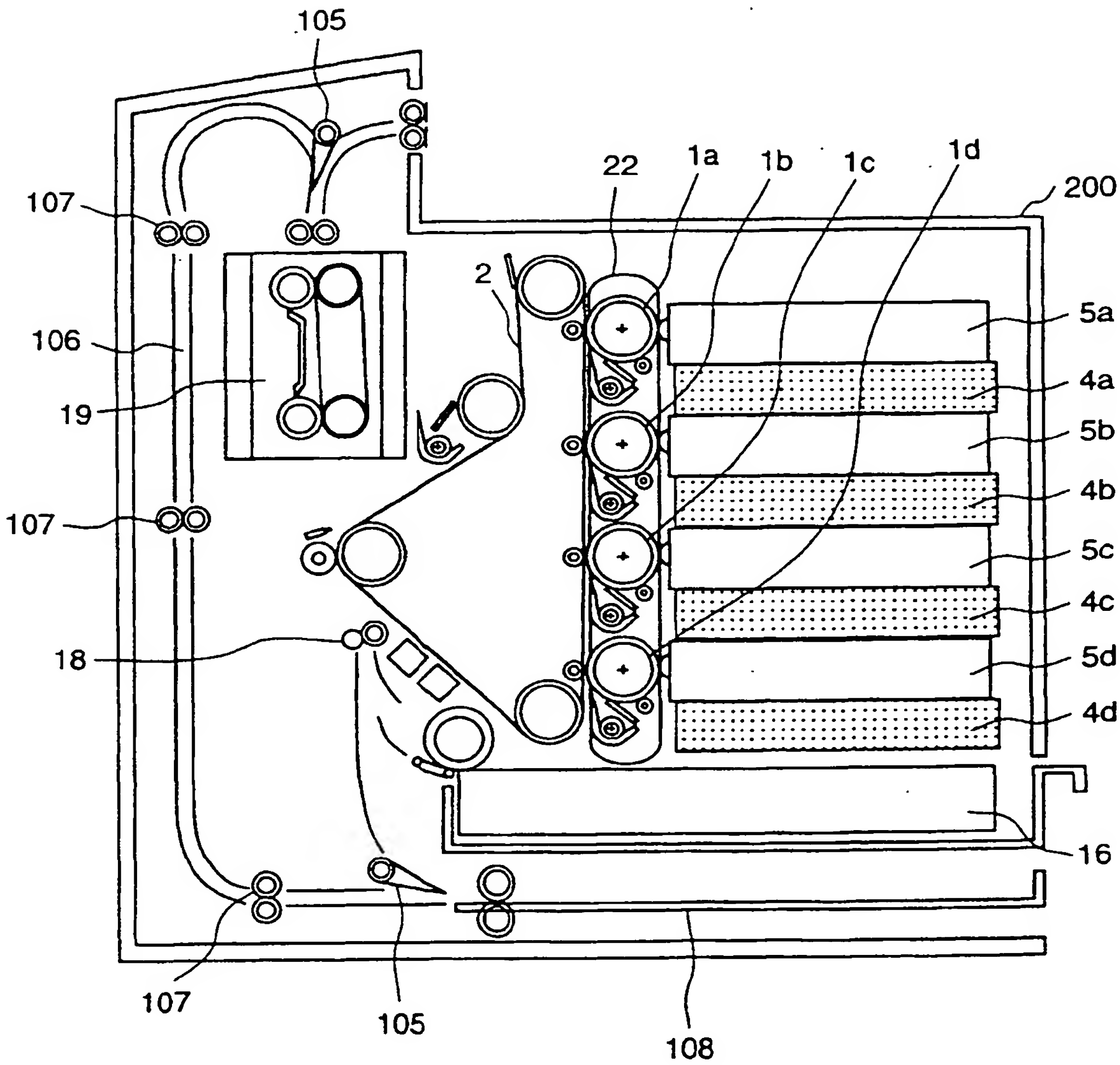

105
107
106
19
107
18
107
105
108
22
1a
1b
1c
1d
200
2
5a
4a
5b
4b
5c
4c
5d
4d
16

FIG. 25

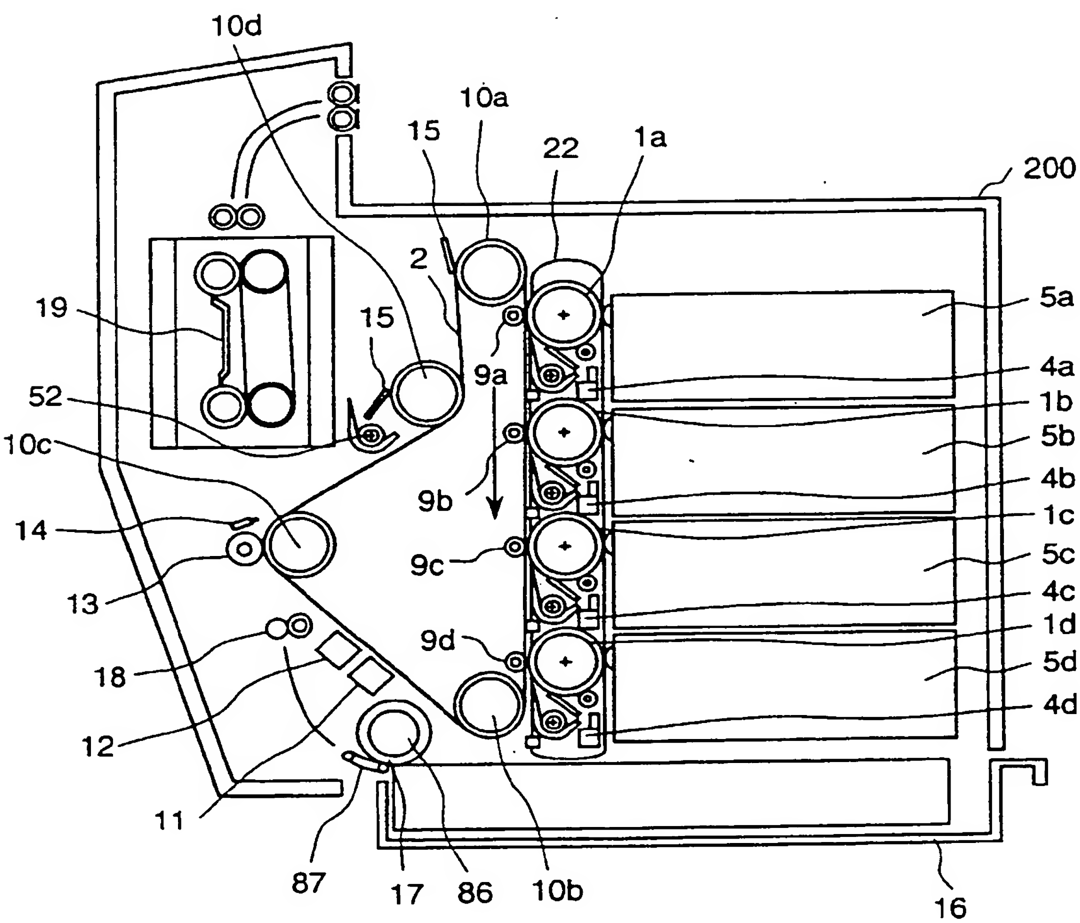

10d
10a
15
22
1a
200
2
5a
19
15
9a
4a
52
1b
10c
5b
9b
4b
1c
14
9c
5c
13
4c
1d
9d
18
5d
4d
12
11
87
17
86
10b
16

FIG. 26

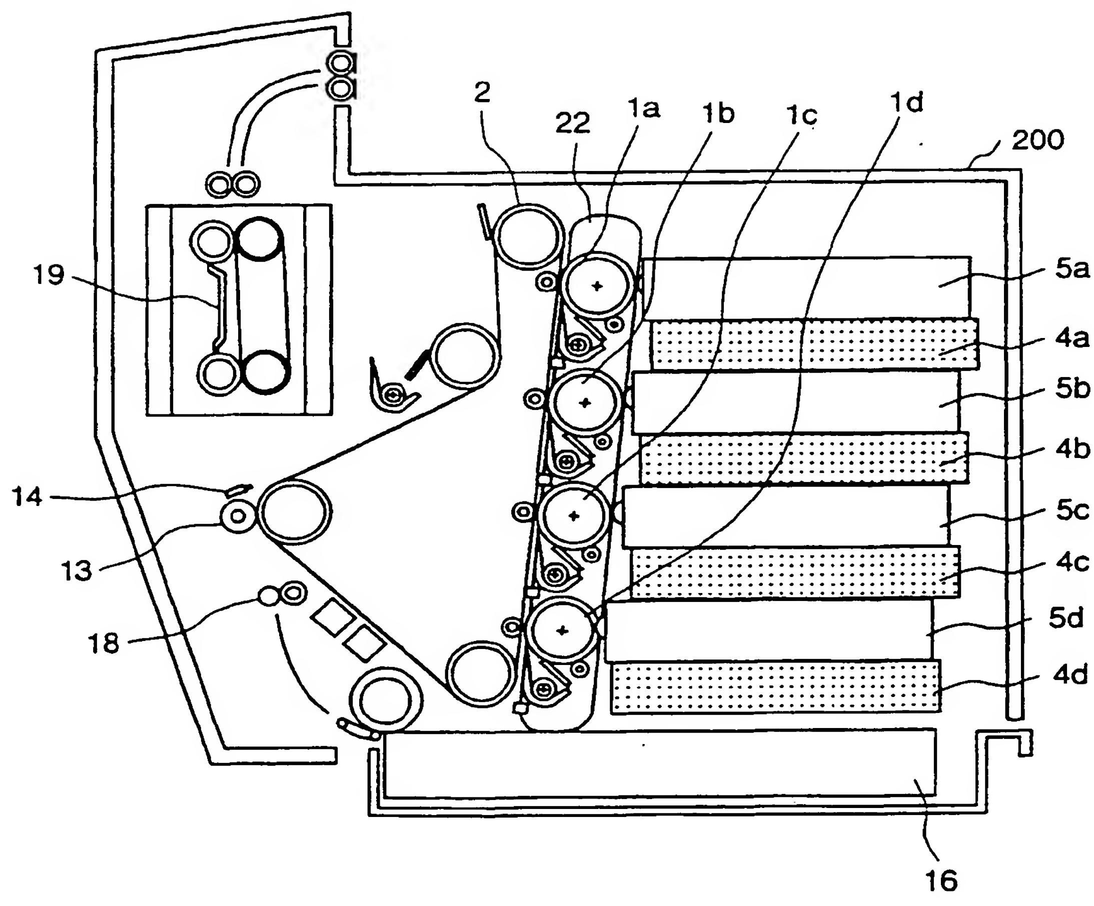


FIG. 27

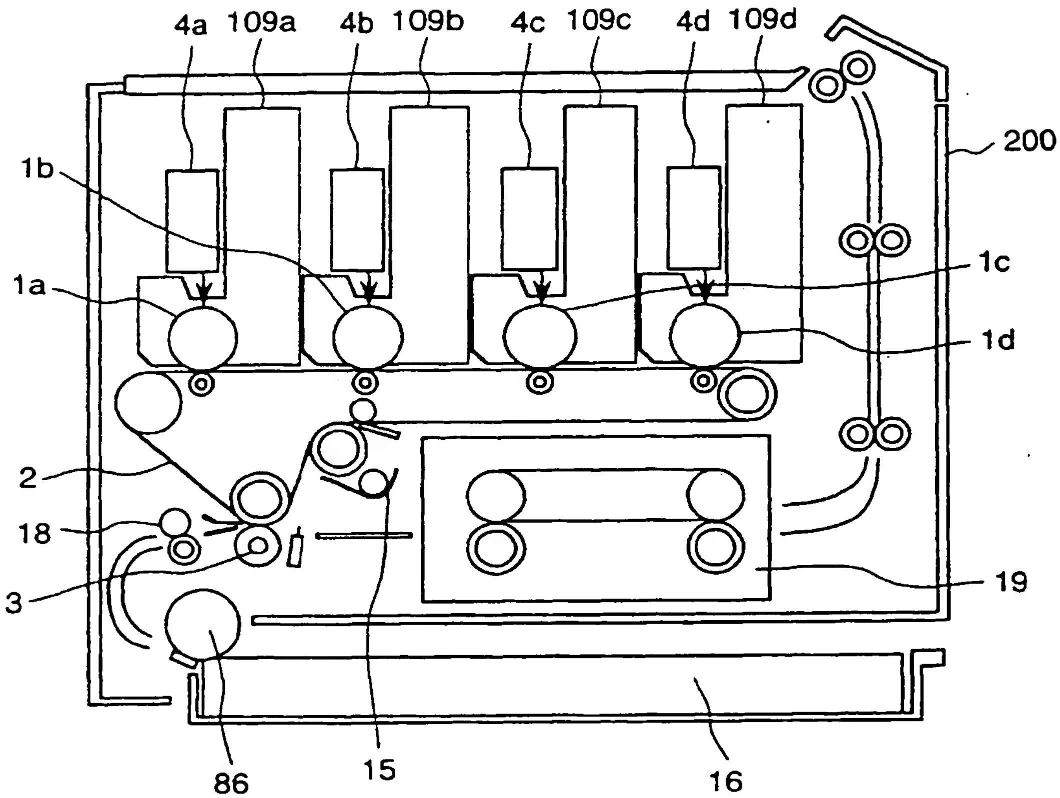
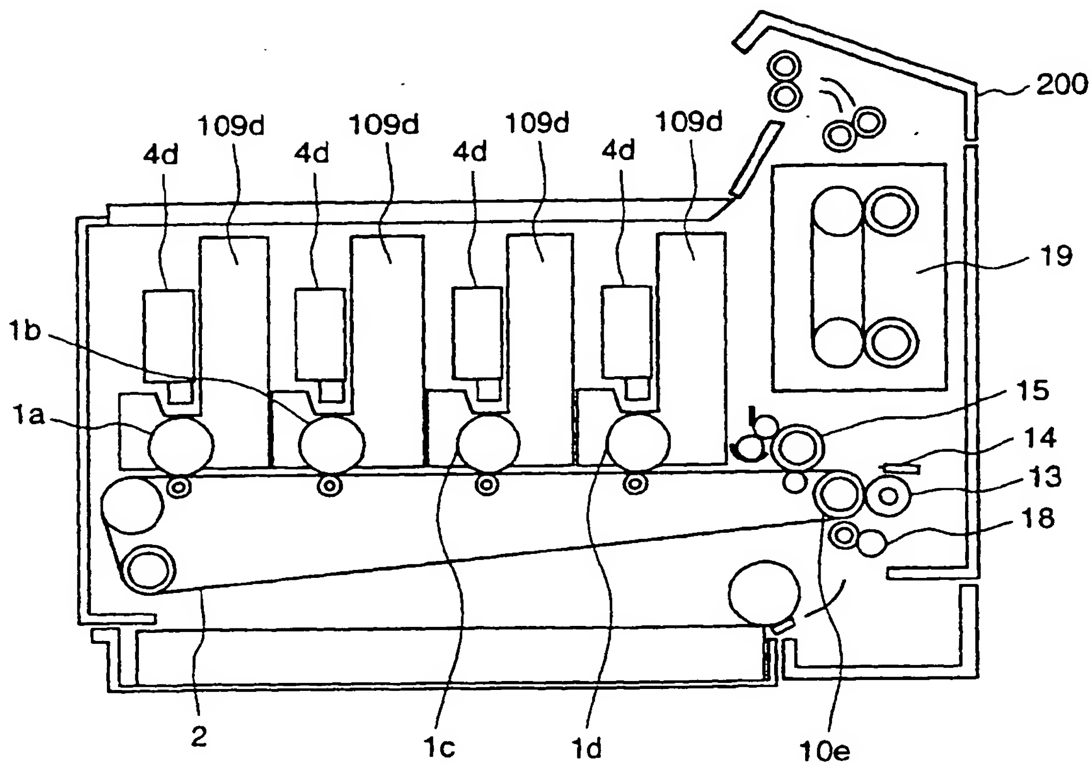


FIG. 28



(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 098 228 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
18.06.2003 Bulletin 2003/25

(51) Int Cl.7: **G03G 15/01**, G03G 21/18

(43) Date of publication A2:
09.05.2001 Bulletin 2001/19

(21) Application number: 00117336.8

(22) Date of filing: 21.08.2000

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 02.11.1999 JP 31194099

(71) Applicant: Hitachi, Ltd.
Chiyoda-ku, Tokyo 101-8010 (JP)

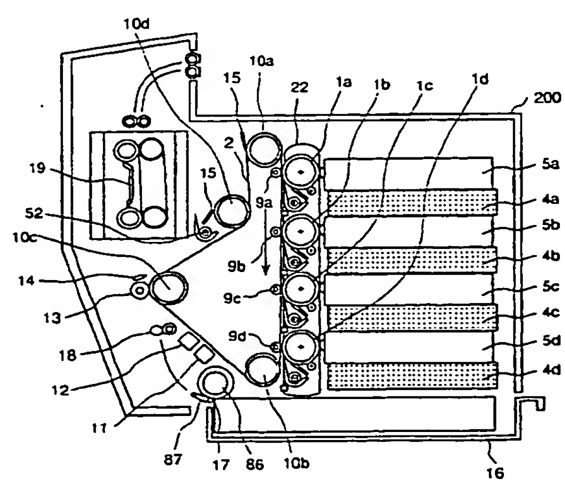
(72) Inventors:
- Yamamoto, Masashi
  Hitachi-shi, Ibaraki 319-1222 (JP)
- Miyasaka, Toru, Erudemu Otsuka room 107
  Hitachi-shi, Ibaraki 319-1225 (JP)
- Nakano, Masaru
  Tsukuba-shi, Ibaraki 300-2637 (JP)
- Shimada, Akira
  Hitachi-shi, Ibaraki 319-1225 (JP)
- Mori, Kenji
  Tsuchiura-shi, Ibaraki 300-0016 (JP)
- Sasaki, Akira
  Hitachi-shi, Ibaraki 316-0012 (JP)
- Wakamatsu, Kazuhiro
  Hitachi-shi, Ibaraki 316-0025 (JP)

(74) Representative: Beetz & Partner Patentanwälte
Steinsdorfstrasse 10
80538 München (DE)

(54) Photoconductor unit and image forming system

(57) In order to provide an image forming system characterized by compact configuration, high speed printing, high picture quality recording and excellent maintainability without image misregistration, an image forming system is provided, wherein multiple photoconductors (1a-d) are arranged on one of the surfaces of the intermediate transfer belt (2) stretched long in the longitudinal direction, and a fusing device (19) on the other surface, with photoconductor integrated in one unit (22).

FIG. 1



EP 1 098 228 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 11 7336

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	PATENT ABSTRACTS OF JAPAN vol. 013, no. 329 (P-904), 25 July 1989 (1989-07-25) & JP 01 094356 A (RICOH CO LTD), 13 April 1989 (1989-04-13)	1,2,20	G03G15/01 G03G21/18
A	* abstract *	17	
A	US 5 787 324 A (IWASAKI TAKEO) 28 July 1998 (1998-07-28) * the whole document *	1,17,20	
A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 012 (P-655), 14 January 1988 (1988-01-14) & JP 62 169175 A (CANON INC), 25 July 1987 (1987-07-25) * abstract *	1,17,20	
X	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 11, 29 November 1996 (1996-11-29) & JP 08 190245 A (KONICA CORP), 23 July 1996 (1996-07-23)	8,10,15	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
Y	* abstract *	1,2,9, 11-13,20	G03G
Y	US 5 502 557 A (CHOI MIN-HO ET AL) 26 March 1996 (1996-03-26) * column 3 - column 4; figure 3 *	9	
Y	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 02, 26 February 1999 (1999-02-26) & JP 10 307489 A (CANON INC), 17 November 1998 (1998-11-17) * abstract *	11,12	
	-/--		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 April 2003	Lipp, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 11 7336

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 08, 29 August 1997 (1997-08-29) & JP 09 090787 A (HITACHI LTD), 4 April 1997 (1997-04-04) * abstract *	13	
A	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 04, 31 May 1995 (1995-05-31) & JP 07 028294 A (MATSUSHITA ELECTRIC IND CO LTD), 31 January 1995 (1995-01-31) * abstract *	1,8,17, 20	
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 08, 30 June 1998 (1998-06-30) & JP 10 063151 A (HITACHI LTD), 6 March 1998 (1998-03-06) * abstract *	1-4	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 April 2003	Lipp, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

Application Number
EP 00 11 7336

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- [ ] Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

- [ ] No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- [x] All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

- [ ] As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

- [ ] Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

- [ ] None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

European Patent Office

LACK OF UNITY OF INVENTION SHEET B

Application Number
EP 00 11 7336

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-7,17-21

   Color image forming system with integral unit for multiple photoconductors.

2. Claims: 8-16

   Color image forming system having alternating arrangement of sub units.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 11 7336

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-04-2003

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
JP 01094356	A	13-04-1989	JP	2690735 B2	17-12-1997
US 5787324	A	28-07-1998	JP	9141972 A	03-06-1997
JP 62169175	A	25-07-1987	NONE		
JP 08190245	A	23-07-1996	NONE		
US 5502557	A	26-03-1996	DE	4438612 A1	19-10-1995
			FR	2718542 A1	13-10-1995
			JP	3103485 B2	30-10-2000
			JP	7287455 A	31-10-1995
JP 10307489	A	17-11-1998	US	5991567 A	23-11-1999
JP 09090787	A	04-04-1997	US	5778294 A	07-07-1998
JP 07028294	A	31-01-1995	NONE		
JP 10063151	A	06-03-1998	NONE		

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82